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10. INTAKE OF FISH AND SHELLFISH

10.1. BACKGROUND

Contaminated finfish and shellfish are potential sources of human exposure to toxic chemicals. Pollutants are carried in the surface waters, but also may be stored and accumulated in the sediments as a result of complex physical and chemical processes. Consequently, finfish and shellfish are exposed to these pollutants and may become sources of contaminated food.

Accurately estimating exposure to a toxic chemical among a population that consumes fish from a polluted water body requires an estimation of intake rates of the caught fish by both fishermen and their families. Commercially caught fish are marketed widely, making the prediction of an individual's consumption from a particular commercial source difficult. Since the catch of recreational and subsistence fishermen is not "diluted" in this way, these individuals and their families represent the population that is most vulnerable to exposure by intake of contaminated fish from a specific location.

This section focuses on intake rates of fish. Note that in this section the term fish refers to both finfish and shellfish. The following subsections address intake rates for the general population, and recreational and subsistence fishermen. Data are presented for intake rates for both marine and freshwater fish, when available. The available studies have been classified as either key or relevant based on the guidelines given in Volume I, Section 1.3. Recommended intake rates are based on the results of key studies, but other relevant studies are also presented to provide the reader with added perspective on the current state-of-knowledge pertaining to fish intake.

Survey data on fish consumption have been collected using a number of different approaches which need to be considered in interpreting the survey results. Generally, surveys are either "creel" studies in which fishermen are interviewed while fishing, or broader population surveys using either mailed questionnaires or phone interviews. Both types of data can be useful for exposure assessment purposes, but somewhat different applications and interpretations are needed. In fact, results from creel studies have often been misinterpreted, due to inadequate knowledge of survey principles. Below, some basic facts about survey design are presented, followed by an analysis of the differences between creel and population based studies.

The typical survey seeks to draw inferences about a larger population from a smaller sample of that population. This larger population, from which the survey sample is to be taken and to which the results of the survey are to be generalized, is denoted the target population of the survey. In order to generalize from the sample to the target population, the probability of being sampled must be known for each member of the target population. This probability is reflected in weights assigned to each survey respondent, with weights being inversely proportional to sampling probability. When all members of the target population have the same probability of being sampled, all weights can be set to one and essentially ignored.

In a mail or phone study of licensed anglers, the target population is generally all licensed anglers in a particular area, and in the studies presented, the sampling probability is essentially equal for all target population members. In a creel study, the target population is anyone who fishes at the locations being studied; generally, in a creel study, the probability of being sampled is not the same for all members of the target population. For instance, if the survey is conducted for one day at a site, then it will include all persons who fish there daily but only about 1/7 of the people who fish there weekly, 1/30th of the people who fish there monthly, etc. In this example, the probability of being sampled (or inverse weight) is seen to be proportional to the frequency of fishing. However, if the survey involves interviewers revisiting the same site on multiple days, and persons are only interviewed once for the survey, then the probability of being in the survey is not proportional to frequency; in fact, it increases less than proportionally with frequency. At the extreme of surveying the same site every day over the survey period with no re-interviewing, all members of the target population would have the same probability of being sampled regardless of fishing frequency, implying that the survey weights should all equal one.

On the other hand, if the survey protocol calls for individuals to be interviewed each time an interviewer encounters them (i.e., without regard to whether they were previously interviewed), then the inverse weights will again be proportional to fishing frequency, no matter how many times interviewers revisit the same site. Note that when individuals can be interviewed multiple times, the results of each interview are included as separate records in the data base and the survey weights should be inversely proportional to the expected number of times that an individual's interviews are included in the data base.

In the published analyses of most creel studies, there is no mention of sampling weights; by default all

weights are set to 1, implying equal probability of sampling. However, since the sampling probabilities in a creel study, even with repeated interviewing at a site, are highly dependent on fishing frequency, the fish intake distributions reported for these surveys are not reflective of the corresponding target populations. Instead, those individuals with high fishing frequencies are given too big a weight and the distribution is skewed to the right, i.e., it overestimates the target population distribution.

Price et al. (1994) explained this problem and set out to rectify it by adding weights to creel survey data; he used data from two creel studies (Puffer et al., 1981 and Pierce et al., 1981) as examples. Price et al. (1994) used inverse fishing frequency as survey weights and produced revised estimates of median and 95th percentile intake for the above two studies. These revised estimates were dramatically lower than the original estimates. The approach of Price et al. (1994) is discussed in more detail in Section 10.5 where the Puffer et al. (1981) and Pierce et al. (1981) studies are summarized.

When the correct weights are applied to survey data, the resulting percentiles reflect, on average, the distribution in the target population; thus, for example, an estimated 90 percent of the target population will have intake levels below the 90th percentile of the survey fish intake distribution. There is another way, however, of characterizing distributions in addition to the standard percentile approach; this approach is reflected in statements of the form "50 percent of the income is received by, for example, the top 10 percent of the population, which consists of individuals making more than $100,000", for example. Note that the 50th percentile (median) of the income distribution is well below $100,000. Here the $100,000 level can be thought of as, not the 50th percentile of the population income distribution, but as the 50th percentile of the "resource utilization distribution" (see Appendix 10A for technical discussion of this distribution). Other percentiles of the resource utilization distribution have similar interpreta-tions; e.g., the 90th percentile of the resource utilization distribution (for income) would be that level of income such that 90 percent of total income is received by individuals with incomes below this level and 10 percent by individuals with income above this level. This alternative approach to characterizing distributions is of particular interest when a relatively small fraction of individuals consumes a relatively large fraction of a resource, which is the case with regards to recreational fish consumption. In the studies of recreational anglers, this alternative approach, based on resource utilization, will be presented, where possible, in addition to the primary approach of presenting the standard percentiles of the fish intake distribution.

It has been determined that the resource utilization approach to characterizing distributions has relevance to the interpretation of creel survey data. As mentioned above, most published analyses of creel surveys do not employ weights reflective of sampling probability, but instead give each respondent equal weight. For mathematical reasons that are explained in Appendix 10A, when creel analyses are performed in this (equal weighting) manner, the calculated percentiles of the fish intake distribution do not reflect the percentiles of the target population fish intake distribution but instead reflect (approximately) the percentiles of the "resource utilization distribution". Thus, one would not expect 50 percent of the target population to be consuming above the median intake level as reported from such a creel survey, but instead would expect that 50 percent of the total recreational fish consumption would be individuals consuming above this level. As with the example above, and in accordance with the statement above that creel surveys analyzed in this manner overestimate intake distributions, the actual median level of intake in the target population will be less (probably considerably so) than this level and, accordingly, (considerably) less than 50 percent of the target population will be consuming at or above this level. These considerations are discussed when the results of individual creel surveys are presented in later sections and should be kept in mind whenever estimates based on creel survey data are utilized.

The U.S. EPA has prepared a review of and an evaluation of five different survey methods used for obtaining fish consumption data. They are:

- Recall-Telephone Survey;
- Recall-Mail Survey;
- Recall-Personal Interview;
- Diary; and
- Creel Census.

The reader is referred to *U.S. EPA 1992-Consumption Surveys for Fish and Shellfish* for more detail on these survey methods and their advantages and limitations.

10.2. KEY GENERAL POPULATION STUDIES

Tuna Research Institute Survey - The Tuna Research Institute (TRI) funded a study of fish

consumption which was performed by the National Purchase Diary (NPD) during the period of September, 1973 to August, 1974. The data tapes from this survey were obtained by the National Marine Fisheries Service (NMFS), which later, along with the FDA, USDA and TRI, conducted an intensive effort to identify and correct errors in the data base. Javitz (1980) summarized the TRI survey methodology and used the corrected tape to generate fish intake distributions for various sub-populations.

The TRI survey sample included 6,980 families who were currently participating in a syndicated national purchase diary panel, 2,400 additional families where the head of household was female and under 35 years old; and 210 additional black families (Javitz, 1980). Of the 9,590 families in the total sample, 7,662 families (25,162 individuals) completed the questionnaire, a response rate of 80 percent. The survey was weighted to represent the U.S. population based on a number of census-defined controls (i.e., census region, household size, income, presence of children, race and age). The calculations of means, percentiles, etc. were performed on a weighted basis with each person contributing in proportion to his/her assigned survey weight.

The survey population was divided into 12 different sample segments and, for each of the 12 survey months, data were collected from a different segment. Each survey household was given a diary in which they recorded, over a one month period, the date of any fish meals consumed and the following accompanying information: the species of fish consumed, whether the fish was commercially or recreationally caught, the way the fish was packaged (canned, frozen fresh, dried, smoked), the amount of fish prepared and consumed, and the number of servings consumed by household members and guests. Both meals eaten at home and away from home were recorded. The amount of fish prepared was determined as follows (Javitz, 1980): "For fresh fish, the weight was recorded in ounces and may have included the weight of the head and tail. For frozen fish, the weight was recorded in packaged ounces, and it was noted whether the fish was breaded or combined with other ingredients (e.g., TV dinners). For canned fish, the weight was recorded in packaged ounces and it was noted whether the fish was canned in water, oil, or with other ingredients (e.g., soups)".

Javitz (1980) reported that the corrected survey tapes contained data on 24,652 individuals who consumed fish in the survey month and that tabulations performed by NPD indicated that these fish consumers represented 94 percent of the U.S. population. For this population of "fish consumers", Javitz (1980) calculated means and percentiles of fish consumption by demographic variables (age, sex, race, census region and community type) and overall (Tables 10-1 through 10-4). The overall mean fish intake rate among fish consumers was calculated at 14.3 g/day and the 95th percentile at 41.7 g/day.

As seen in Table 10-1, the mean and 95th percentile of fish consumption were higher for Asian-Americans as compared to the other racial groups. Other differences in intake rates are those between gender and age groups. While males (15.6 g/d) eat slightly more fish than females (13.2 g/d), and adults eat more fish than children, the corresponding differences in body weight would probably compensate for the different intake rates in exposure calculations (Javitz, 1980). There appeared to be no large differences in regional intake rates, although higher rates are shown in the New England and Middle Atlantic census regions.

The mean and 95th percentile intake rates by age-gender groups are presented in Table 10-2. Tables 10-3 and 10-4 present the distribution of fish consumption for females and males, respectively, by age; these tables give the percentages of females/males in a given age bracket with intake rates within various ranges. Table 10-5 presents mean total fish consumption by fish species.

The TRI survey data were also utilized by Rupp et al. (1980) to generate fish intake distributions for three age groups (<11, 12-18, and 19+ years) within each of the 9 census regions and for the entire United States. Separate distributions were derived for freshwater finfish, saltwater finfish and shellfish; thus, a total of 90 (3*3*10) different distributions were derived, each corresponding to intake of a specific category of fish for a given age group within a given region. The analysis of Rupp et al. (1980) included only those respondents with known age. This amounted to 23,213 respondents.

Ruffle et al. (1994) used the percentiles data of Rupp et al. (1980) to estimate the best fitting lognormal parameters for each distribution. Three methods (non-linear optimization, first probability plot and second probability plot) were used to estimate optimal parameters. Ruffle et al. (1994) determined that, of the three methods, the non-linear optimization method (NLO) generally gave the best results. For some of the distributions fitted by the NLO method, however, it was determined that the lognormal model did not adequately fit the empirical fish intake distribution. Ruffle et al.

(1994) used a criterion of minimum sum of squares (min SS) less than 30 to identify which distributions provided adequate fits. Of the 90 distributions studied, 77 were seen to have min SS < 30; for these, Ruffle et al. (1994) concluded that the NLO modeled lognormal distributions are "well suited for risk assessment". Of the remaining 13 distributions, 12 had min SS > 30; for these Ruffle et al. (1994) concluded that modeled lognormal distributions "may also be appropriate for use when exercised with due care and with sensitivity analyses". One distribution, that of freshwater finfish intake for children < 11 years of age in New England, could not be modeled due to the absence of any reported consumption.

Table 10-6 presents the optimal lognormal parameters, the mean (μ), standard deviation (s), and min SS, for all 89 modeled distributions. These parameters can be used to determine percentiles of the corresponding distribution of average daily fish consumption rates through the relation DFC(p)=exp[μ+ z(p)s] where DFC(p) is the pth percentile of the distribution of average daily fish consumption rates and z(p) is the z-score associated with the pth percentile (e.g., z(50)=0). The mean average daily fish consumption rate is given by exp[$\mu + 0.5s^2$].

The analyses of Javitz (1980) and Ruffle et al. (1994) were based on consumers only, who are estimated to represent 94.0 percent of the U.S. population. U.S. EPA estimated the mean intake in the general population by multiplying the fraction consuming, 0.94, by the mean among consumers reported by Javitz (1980) of 14.3 g/day; the resulting estimate is 13.4 g/day. The 95th percentile estimate of Javitz (1980) of 41.7 g/day among consumers would be essentially unchanged when applied to the general population; 41.7 g/day would represent the 95.3 percentile (i.e., 100*[0.95*0.94+0.06]) among the general population.

Advantages of the TRI data survey are that it was a large, nationally representative survey with a high response rate (80 percent) and was conducted over an entire year. In addition, consumption was recorded in a daily diary over a one month period; this format should be more reliable than one based on one-month recall. The upper percentiles presented are derived from one month of data, and are likely to overestimate the corresponding upper percentiles of the long-term (i.e., one year or more) average daily fish intake distribution. Similarly, the standard deviation of the fitted lognormal distribution probably overestimates the standard deviation of the long-term distribution. However, the period of this survey (one month) is considerably longer than those of many other consumption studies, including the USDA National Food Consumption Surveys, which report consumption over a 3 day to one week period.

Another obvious limitation of this data base is that it is now over twenty years out of date. Ruffle et al. (1994) considered this shortcoming and suggested that one may wish to shift the distribution upward to account for the recent increase in fish consumption. Adding ln(1+x/100) to the log mean μ will shift the distribution upward by x percent (e.g., adding 0.22 = ln(1.25) increases the distribution by 25 percent). Although the TRI survey distinguished between recreationally and commercially caught fish, Javitz (1980), Rupp et al. (1980), and Ruffle et al. (1994) (which was based on Rupp et al., 1980) did not present analyses by this variable.

U.S. EPA (1996a) - Daily Average Per Capita Fish Consumption Estimates Based on the Combined USDA 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals (CSFII) — The USDA conducts the CSFII on an ongoing basis. U.S. EPA used the 1989, 1990, and 1991 CSFII data to generate fish intake estimates. Participants in the CSFII provided 3 consecutive days of dietary data. For the first day's data, participants supplied dietary recall information to an in-home interviewer. Second and third day dietary intakes were recorded by participants. Data collection for the CSFII started in April of the given year and was completed in March of the following year.

The CSFII contains 469 fish-related food codes; survey respondents reported consumption across 284 of these codes. Respondents estimated the weight of each food that they consumed. The fish component (by weight) of these foods was calculated using data from the recipe file for release 7 of the USDA's Nutrient Data Base for Individual Food Intake Surveys. The amount of fish consumed by each individual was then calculated by summing, over all fish containing foods, the product of the weight of food consumed and the fish component (i.e., the percentage fish by weight) of the food.

The recipe file also contains cooking loss factors associated with each food. These were utilized to convert, for each fish containing food, the as-eaten fish weight consumed into an uncooked equivalent weight of fish. Analyses of fish intake were performed on both an as-eaten and uncooked basis.

Each (fish-related) food code was assigned by EPA a habitat type of either freshwater/estuarine or marine. Food codes were also designated as finfish or shellfish. Average daily individual consumption (g/day) for a given

fish type-by-habitat category (e.g., marine finfish) was calculated by summing the amount of fish consumed by the individual across the three reporting days for all fish-related food codes in the given fish-by-habitat category and then dividing by 3. Individual consumption per day consuming fish (g/day) was calculated similarly except that total fish consumption was divided by the specific number of survey days the individual reported consuming fish; this was calculated for fish consumers only (i.e., those consuming fish on at least one of the three survey days). The reported body-weight of the individual was used to convert consumption in g/day to consumption in g/kg-day.

There were a total of 11,912 respondents in the combined data set who had three-day dietary intake data. Survey weights were assigned to this data set to make it representative of the U.S. population with respect to various demographic characteristics related to food intake.

U.S. EPA (1996a) reported means, medians, upper percentiles, and 90-percent interval estimates for the 90th, 95th, and 99th percentiles. The 90-percent interval estimates are nonparametric estimates from bootstrap techniques. The bootstrap estimates result from the percentile method which estimates the lower and upper bounds for the interval estimate by the 100α percentile and 100 (1-α) percentile estimates from the non-parametric distribution of the given point estimate (U.S. EPA, 1996a).

Analyses of fish intake were performed on an as-eaten as well as on an uncooked equivalent basis and on a g/day and g/kg-day basis. Table 10-7 gives the mean and various percentiles of the distribution of per-capita fish intake rates (g/day) based on uncooked equivalent weight by habitat and fish type, for the general population. The mean per capita intake rate of finfish and shellfish from all habitats was 20.1 g/day. Per-capita consumption estimates by species are shown in Appendix 10C. Table 10-8 displays the mean and various percentiles of the distribution of total fish intake per day consuming fish, by habitat for consumers only. Also displayed is the percentage of the population consuming fish of the specified habitat during the three day survey period. Tables 10-9 and 10-10 present similar results as above but on a mg/kg-day basis; Tables 10-11 and 10-12 present results in the same format for fish intake (g/day) on an as-eaten (cooked) basis.

Tables 10-13 through 10-44 present data for daily average per capita fish consumption by age and gender. These data are presented by selected age grouping (4 and under, 15-44, 45 and older, all ages) and gender. Tables 10-13 through 10-20 present fish intake data (g/day and mg/kg-day) on an as consumed basis for the general population and Tables 10-21 through 10-28 for consumers only. Tables 10-29 through 10-44 provide intake data (g/day and mg/kg-day) on an uncooked equivalent basis for the same population groups described above.

The advantages of this study are its large size, its relative currency and its representativeness. In addition, through use of the USDA recipe files, the analysis identified all fish-related food codes and estimated the percent fish content of each of these codes. By contrast, some analyses of the USDA National Food Consumption Surveys (NFCSs) which reported per capita fish intake rates (e.g., Pao et al., 1982; USDA, 1992a), excluded certain fish containing foods (e.g., fish mixtures, frozen plate meals) in their calculations.

Results from the 1977-1978 NFCS survey (Pao et al., 1982) showed that only a small percentage of consumers ate fish on more than one occasion per day. This implies that the distribution presented for fish intake per day consuming fish can be used as a surrogate for the distribution of fish intake per (fish) eating occasion (Table 10-8).

Also, it should be noted that the 1989-91 CSFII data are not the most recent intake survey data. USDA has recently made available data from its 1994 and 1995 CSFII. Over 5,500 people nationwide participated in both of these surveys, providing recalled food intake information for two separate days. Although the 2-day data analysis has not been conducted, USDA published results for the respondents' intakes on the first day surveyed (USDA, 1996a; USDA, 1996b). USDA 1996 survey data will be made available later in 1997. As soon as 1996 data are available, EPA will take steps to get the 3-year data (1994, 1995, 1996) analyzed and the food ingestion factors updated. Meanwhile, comparisons between the mean daily fish intake per individual in a day from the USDA survey data from years 1977-78, 1987-88, 1989-91, 1994, and 1995 indicate that fish intake has been relatively constant over time. The 1-day fish intake rates were 11 g/day, 11 g/day, 13 g/day, 9 g/day, and 11 g/day for survey years 1977-78, 1987-88, 1989-91, 1994, and 1995, respectively. This indicates that the 1989-91 CSFII data presented in this handbook are probably adequate for assessing fish ingestion exposure for current populations.

10.3. RELEVANT GENERAL POPULATION STUDIES

Pao et al. (1982) - Foods Commonly Eaten by Individuals: Amount Per Day and Per Eating Occasion - The USDA 1977-78 Nationwide Food Consumption Survey (NFCS) was described in Chapter 9. The survey consisted of a household and individual component. For the individual component, all members of surveyed households were asked to provide 3 consecutive days of dietary data. For the first day's data, participants supplied dietary recall information to an in-home interviewer. Second and third day dietary intakes were recorded by participants. A total of 15,000 households were included in the 1977-78 NFCS and about 38,000 individuals completed the 3-day diet records. Fish intake was estimated based on consumption of fish products identified in the NFCS data base according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw and dried fish, but not fish mixtures or frozen plate meals.

Pao et al. (1982) used the 1977-78 NFCS to examine the quantity of fish consumed per eating occasion. For each individual consuming fish in the 3 day survey period, the quantity of fish consumed per eating occasion was derived by dividing the total reported fish intake over the 3 day period by the number of occasions the individual reported eating fish. The distributions, by age and sex, for the quantity of fish consumed per eating occasion are displayed in Table 10-13 (Pao et al., 1982). For the general population, the average quantity of fish consumed per fish meal was 117 g, with a 95th percentile of 284 g. Males in the age groups 19-34, 35-64 and 65-74 years had the highest average and 95th percentile quantities among the age-sex groups presented.

Pao et al. (1982) also used the data from this survey set to calculate per capita fish intake rates. However, because these data are now almost 20 years out of date, this analysis is not considered key with respect to assessing per capita intake (the average quantity of fish consumed per fish meal should be less subject to change over time than is per capita intake). In addition, fish mixtures and frozen plate meals were not included in the calculation of fish intake. The per capita fish intake rate reported by Pao et al. (1982) was 11.8 g/day. The 1977-1978 NFCS was a large and well designed survey and the data are representative of the U.S. population.

USDA Nationwide Food Consumption Survey 1987-88 - The USDA 1987-88 Nationwide Food Consumption Survey (NFCS) was described in Chapter 9. Briefly, the survey consisted of a household and individual component. The household component asked about household food consumption over the past one week period. For the individual component, each member of a surveyed household was interviewed (in person) and asked to recall all foods eaten the previous day; the information from this interview made up the "one day data" for the survey. In addition, members were instructed to fill out a detailed dietary record for the day of the interview and the following day. The data for this entire 3-day period made up the "3-day diet records". A statistical sampling design was used to ensure that all seasons, geographic regions of the U.S., demographic, and socioeconomic groups were represented. Sampling weights were used to match the population distribution of 13 demographic characteristics related to food intake (USDA, 1992a).

Total fish intake was estimated based on consumption of fish products identified in the NFCS data base according to NFCS-defined food codes. These products included fresh, breaded, floured, canned, raw and dried fish, but not fish mixtures or frozen plate meals.

A total of 4,500 households participated in the 1987-88 survey; the household response rate was 38 percent. One day data were obtained for 10,172 (81 percent) of the 12,522 individuals in participating households; 8,468 (68 percent) individuals completed 3-day diet records.

USDA (1992b) used the one day data to derive per capita fish intake rate and intake rates for consumers of total fish. These rates, calculated by sex and age group, are shown in Table 10-14. Intake rates for consumers-only were calculated by dividing the per capita intake rates by the fractions of the population consuming fish in one day.

The 1987-1988 NFCS was also utilized to estimate consumption of home produced fish (as well as home produced fruits, vegetables, meats and dairy products) in the general U.S. population. The methodology for estimating home-produced intake rates was rather complex and involved combining the household and individual components of the NFCS; the methodology, as well as the estimated intake rates, are described in detail in Chapter 12. However, since much of the rest of this chapter is concerned with estimating consumption of recreationally caught, i.e., home produced fish, the methods and results of Chapter 12, as they pertain to fish consumption, are summarized briefly here.

A total of 2.1 percent of the survey population reported home produced fish consumption during the survey week. Among consumers, the mean intake rate was 2.07 g/kg-day and the 95th percentile was 7.83 g/kg-day; the per-capita intake rate was 0.04 g/kg-day. Note that intake rates for home-produced foods were indexed to the weight of the survey respondent and reported in g/kg-day.

It is possible to compare the estimates of home-produced fish consumption derived in this analyses with estimates derived from studies of recreational anglers (described in Sections 10.4-10.8); however, the intake rates must be put into a similar context. The home-produced intake rates described refer to average daily intake rates among individuals consuming home-produced fish in a week; results from recreational angler studies, however, usually report average daily rates for those eating home-produced fish (or for those who recreationally fish) at least some time during the year. Since many of these latter individuals eat home-produced fish at a frequency of less than once per week, the average daily intake in this group would be expected to be less than that reported.

The NFCS household component contains the question "Does anyone in your household fish?". For the population answering yes to this question (21 percent of households), the NFCS data show that 9 percent consumed home-produced fish in the week of the survey; the mean intake rate for these consumers from fishing households was 2.2 g/kg-day. (Note that 91 percent of individuals reporting home grown fish consumption for the week of the survey indicated that a household member fishes; the overall mean intake rate among home-produced fish consumers, regardless of fishing status, was the above reported 2.07 g/kg-day). The per capita intake rate among those living in a fishing household is then calculated as 0.2 g/kg-day (2.2 * 0.09). Using the estimated average weight of survey participants of 59 kg, this translates into 11.8 g/day. Among members of fishing households, home-produced fish consumption accounted for 32.5 percent of total fish consumption.

As discussed in Chapter 12 of this volume, intake rates for home-produced foods, including fish, are based on the results of the household survey, and as such, reflect the weight of fish taken into the household. In most of the recreational fish surveys discussed later in this section, the weight of the fish catch (which generally corresponds to the weight taken into the household) is multiplied by an edible fraction to convert to an uncooked equivalent of the amount consumed. This fraction may be species specific, but some studies used an average value; these average values ranged from 0.3 to 0.5. Using a factor of 0.5 would convert the above 11.8 g/day rate to 5.9 g/day. This estimate, 5.9 g/day, of the per-capita fish intake rate among members of fishing households is within the range of the per-capita intake rates among recreational anglers addressed in sections to follow.

An advantage of analyses based on the 1987-1988 USDA NFCS is that the data set is a large, geographically and seasonally balanced survey of a representative sample of the U.S. population. The survey response rate, however, was low and an expert panel concluded that it was not possible to establish the presence or absence of non-response bias (USDA, 1992b). Limitations of the home-produced analysis are given in Chapter 12 of this volume.

Tsang and Klepeis (1996) - National Human Activity Pattern Survey (NHAPS) - The U.S. EPA collected information for the general population on the duration and frequency of time spent in selected activities and time spent in selected microenvironments via 24-hour diaries. Over 9,000 individuals from 48 contiguous states participated in NHAPS. Approximately 4,700 participants also provided information on seafood consumption. The survey was conducted between October 1992 and September 1994. Data were collected on the (1) number of people that ate seafood in the last month, (2) the number of servings of seafood consumed, and (3) whether the seafood consumed was caught or purchased (Tsang and Klepeis, 1996). The participant responses were weighted according to selected demographics such as age, gender, and race to ensure that results were representative of the U.S. population. Of those 4,700 respondents, 2,980 (59.6 percent) ate seafood (including shellfish, eels, or squid) in the last month (Table 10-15). The number of servings per month were categorized in ranges of 1-2, 3-5, 6-10, 11-19, and 20+ servings per month (Table 10-16). The highest percentage (35 percent) of respondent population had an intake of 3-5 servings per month. Most (92 percent) of the respondents purchased the seafood they ate (Table 10-17).

Intake data were not provided in the survey. However, intake of fish can be estimated using the information on the number of servings of fish eaten from this study and serving size data from other studies. The recommended mean value in this handbook for fish serving size is 129 g/serving (Table 10-8). Using this mean value for serving size and assuming that the average

individual eats 3-5 servings per month, the amount of seafood eaten per month would range from 387 to 645 grams/month or 12.9 to 21.5 g/day for the highest percentage of the population. These values are within the range of mean intake values for total fish (20.1 g/day) calculated in the U.S. EPA analysis of the USDA CSFII data. It should be noted that an all inclusive description for seafood was not presented in Tsang and Klepeis (1996). It is not known if processed or canned seafood and seafood mixtures are included in the seafood category.

The advantages of NHAPS is that the data were collected for a large number of individuals and are representative of the U.S. general population. However, evaluation of seafood intake was not the primary purpose of the study and the data do not reflect the actual amount of seafood that was eaten. However, using the assumption described above, the estimated seafood intake from this study are comparable to those observed in the EPA CSFII analysis.

10.4. KEY RECREATIONAL (MARINE FISH STUDIES)

National Marine Fisheries Service (1986a, b, c; 1993) - The National Marine Fisheries Service (NMFS) conducts systematic surveys, on a continuing basis, of marine recreational fishing. These surveys are designed to estimate the size of the recreational marine finfish catch by location, species and fishing mode. In addition, the surveys provide estimates for the total number of participants in marine recreational finfishing and the total number of fishing trips. The surveys are not designed to estimate individual consumption of fish from marine recreational sources, primarily because they do not attempt to estimate the number of individuals consuming the recreational catch. Intake rates for marine recreational anglers can be estimated, however, by employing assumptions derived from other data sources about the number of consumers.

The NMFS surveys involve two components, telephone surveys and direct interviewing of fishermen in the field. The telephone survey randomly samples residents of coastal regions, defined generally as counties within 25 miles of the nearest seacoast, and inquires about participation in marine recreational fishing in the resident's home state in the past year, and more specifically, in the past two months. This component of the survey is used to estimate, for each coastal state, the total number of coastal region residents who participate in marine recreational fishing (for finfish) within the state, as well as the total number of (within state) fishing trips these residents take. To estimate the total number of participants and fishing trips in the state, by coastal residents and others, a ratio approach, based on the field interview data, was used. Thus, if the field survey data found that there was a 4:1 ratio of fishing trips taken by coastal residents as compared to trips taken by non-coastal and out of state residents, then an additional 25 percent would be added to the number of trips taken by coastal residents to generate an estimate of the total number of within state trips.

The field intercept survey is essentially a creel type survey. The survey utilizes a national site register which details marine fishing locations in each state. Sites for field interviews are chosen in proportion to fishing frequency at the site. Anglers fishing on shore, private boat, and charter/party boat modes who had completed their fishing were interviewed. The field survey included questions about frequency of fishing, area of fishing, age, and place of residence. The fish catch was classified by the interviewer as either type A, type B1 or type B2 catch. The type A catch denoted fish that were taken whole from the fishing site and were available for inspection. The type B1 and B2 catch were not available for inspection; the former consisted of fish used as bait, filleted, or discarded dead while the latter was fish released alive. The type A catch was identified by species and weighed, with the weight reflecting total fish weight, including inedible parts. The type B1 catch was not weighed, but weights were estimated using the average weight derived from the type A catch for the given species, state, fishing mode and season of the year. For both the A and B1 catch, the intended disposition of the catch (e.g., plan to eat, plan to throw away, etc.) was ascertained.

EPA obtained the raw data tapes from NMFS in order to generate intake distributions and other specialized analyses. Fish intake distributions were generated using the field survey tapes. Weights proportional to the inverse of the angler's reported fishing frequency were employed to correct for the unequal probabilities of sampling; this was the same approach used by NMFS in deriving their estimates. Note that in the field survey, anglers were interviewed regardless of past interviewing experience; thus, the use of inverse fishing frequency as weights was justified (see Section 10.1).

For each angler interviewed in the field survey, the yearly amount of fish caught that was intended to be eaten

by the angler and his/her family or friends was estimated by EPA as follows:

$$Y = [(\text{wt of A catch}) * I_A + (\text{wt of B1 catch}) * I_B] * [\text{Fishing frequency}] \quad \text{(Eqn. 10-1)}$$

where I_A (I_B) are indicator variables equal to 1 if the type A (B1) catch was intended to be eaten and equal to 0 otherwise. To convert Y to a daily fish intake rate by the angler, it was necessary to convert amount of fish caught to edible amount of fish, divide by the number of intended consumers, and convert from yearly to daily rate. Although theoretically possible, EPA chose not to use species specific edible fractions to convert overall weight to edible fish weight since edible fraction estimates were not readily available for many marine species. Instead, an average value of 0.5 was employed. For the number of intended consumers, EPA used an average value of 2.5 which was an average derived from the results of several studies of recreational fish consumption (Chemrisk, 1991; Puffer et al., 1981; West et al., 1989). Thus, the average daily intake rate (ADI) for each angler was calculated as

$$ADI = Y * (0.5)/[2.5 * 365] \quad \text{(Eqn. 10-2)}$$

Note that ADI will be 0 for those anglers who either did not intend to eat their catch or who did not catch any fish. The distribution of ADI among anglers was calculated by region and coastal status (i.e., coastal versus non-coastal counties). A mean ADI for the overall population of a given area was calculated as follows: first the estimated number of anglers in the area was multiplied by the average number of intended fish consumers (2.5) to get a total number of recreational marine finfish consumers. This number was then multiplied by the mean ADI among anglers to get the total recreational marine finfish consumption in the area. Finally, the mean ADI in the population was calculated by dividing total fish consumption by the total population in the area.

The results presented below are based on the results of the 1993 survey. Samples sizes were 200,000 for the telephone survey and 120,000 for the field surveys. All coastal states in the continental U.S. were included in the survey except Texas and Washington.

Table 10-18 presents the estimated number of coastal, non-coastal, and out-of-state fishing participants by state and region of fishing. Florida had the greatest number of both Atlantic and Gulf participants. The total number of coastal residents who participated in marine finfishing in their home state was 8 million; an additional 750,000 non-coastal residents participated in marine finfishing in their home state.

Table 10-19 presents the estimated total weight of the A and B1 catch by region and time of year. For each region, the greatest catches were during the six-month period from May through October. This period accounted for about 90 percent of the North and Mid-Atlantic catch, about 80 percent of the Northern California and Oregon catch, about 70 percent of the Southern Atlantic and Southern California catch and 62 percent of the Gulf catch. Note that in the North and Mid-Atlantic regions, field surveys were not done in January and February due to very low fishing activity. For all regions, over half the catch occurred within 3 miles of the shore or in inland waterways.

Table 10-20 presents the mean and 95th percentile of average daily intake of recreationally caught marine finfish among anglers by region. The mean ADI among all anglers was 5.6, 7.2, and 2.0 g/day for the Atlantic, Gulf, and Pacific regions, respectively. Also given is the per-capita ADI in the overall population (anglers and non-anglers) of the region and in the overall coastal population of the region. Table 10-21 gives the distribution of the catch by species for the Atlantic and Gulf regions and Table 10-22 for Pacific regions.

The NMFS surveys provide a large, up-to-date, and geographically representative sample of marine angler activity in the U.S. The major limitation of this data base in terms of estimating fish intake is the lack of information regarding the intended number of consumers of each angler's catch. In this analysis, it was assumed that every angler's catch was consumed by the same number (2.5) of people; this number was derived from averaging the results of other studies. This assumption introduces a relatively low level of uncertainty in the estimated mean intake rates among anglers, but a somewhat higher level of uncertainty in the estimated intake distributions. It should be noted that under the above assumption, the distributions shown here pertain not only to the population of anglers, but also to the entire population of recreational fish consumers, which is 2.5 times the number of anglers. If the number of consumers was changed, to, for instance, 2.0, then the distribution would be increased by a factor of 1.25 (2.5/2.0), but the estimated population of recreational fish consumers to which the distribution would apply would decrease by a factor of 0.8 (2.0/2.5). Note that the mean

intake rate of marine finfish in the overall population is independent of the assumption of number of intended fish consumers.

Another uncertainty involves the use of 0.5 as an (average) edible fraction. This figure is somewhat conservative (i.e., the true average edible fraction is probably lower); thus, the intake rates calculated here may be biased upward somewhat.

It should be noted again that the recreational fish intake distributions given refer only to marine finfish. In addition, the intake rates calculated are based only on the catch of anglers in their home state. Marine fishing performed out-of-state would not be included in these distributions. Therefore, these distributions give an estimate of consumption of locally caught fish.

10.5. RELEVANT RECREATIONAL MARINE STUDIES

Puffer et al. (1981) - Intake Rates of Potentially Hazardous Marine Fish Caught in the Metropolitan Los Angeles Area - Puffer et al. (1981) conducted a creel survey with sport fishermen in the Los Angeles area in 1980. The survey was conducted at 12 sites in the harbor and coastal areas to evaluate intake rates of potentially hazardous marine fish and shellfish by local, non-professional fishermen. It was conducted for the full 1980 calendar year, although inclement weather in January, February, and March limited the interview days. Each site was surveyed an average of three times per month, on different days, and at a different time of the day. The survey questionnaire was designed to collect information on demographic characteristics, fishing patterns, species, number of fish caught, and fish consumption patterns. Scales were used to obtain fish weights. Interviews were conducted only with anglers who had caught fish, and the anglers were interviewed only once during the entire survey period.

Puffer et al. (1981) estimated daily consumption rates (grams/day) for each angler using the following equation:

$$(K \times N \times W \times F)/[E \times 365] \qquad \text{(Eqn. 10-3)}$$

where:

- K = edible fraction of fish (0.25 to 0.5 depending on species);
- N = number of fish in catch;
- W = average weight of (grams) fish in catch;
- F = frequency of fishing/year; and
- E = number of fish eaters in family/living group.

No explicit survey weights were used in analyzing this survey; thus, each respondent's data was given equal weight.

A total of 1,059 anglers were interviewed for the survey. The ethnic and age distribution of respondents is shown in Table 10-23; 88 percent of respondents were male. The median intake rate was higher for Oriental/Samoan anglers (median 70.6 g/day) than for other ethnic groups and higher for those ages over 65 years (median 113.0 g/day) than for other age groups. Puffer et al. (1981) found similar median intake rates for seasons; 36.3 g/day for November through March and 37.7 g/day for April through October. Puffer et al. (1981) also evaluated fish preparation methods; these data are presented in Appendix 10B. The cumulative distribution of recreational fish (finfish and shellfish) consumption by survey respondents is presented in Table 10-24; this distribution was calculated only for those fishermen who indicated they eat the fish they catch. The median fish consumption rate was 37 g/day and the 90th percentile rate was 225 g/day (Puffer et al., 1981). A description of catch patterns for primary fish species kept is presented in Table 10-25.

As mentioned in the Background to this Chapter, intake distributions derived from analyses of creel surveys which did not employ weights reflective of sampling probabilities will overestimate the target population intake distribution and will, in fact, be more reflective of the "resource utilization distribution". Therefore, the reported median level of 37.3 g/day does not reflect the fact that 50 percent of the target population has intake above this level; instead 50 percent of recreational fish consumption is by individuals consuming at or above 37.3 g/day. In order to generate an intake distribution reflective of that in the target population, weights inversely proportional to sampling probability need to be employed. Price et al. (1994) made this attempt with the Puffer et al. (1981) survey data, using inverse fishing frequencies as the sampling weights. Price et al. (1994) was unable to get the raw data for this survey, but using frequency tables and the average level of fish consumption per fishing trip provided in Puffer et al. (1981), generated an approximate revised intake distribution. This distribution was dramatically lower than that obtained by Puffer et al. (1981); the median was estimated at 2.9 g/day (compared with 37.3 from Puffer et al., 1981) and the 90th percentile at 35 g/day (compared to 225 g/day from Puffer et al., 1981).

There are several limitations to the interpretation of the percentiles presented by both Puffer et al. (1981) and Price et al. (1994). As described in Appendix 10A, the interpretation of percentiles reported from creel surveys in terms of percentiles of the "resource utilization distribution" is approximate and depends on several assumptions. One of these assumptions is that sampling probability is proportional to inverse fishing frequency. In this survey, where interviewers revisited sites numerous times and anglers were not interviewed more than once, this assumption is not valid, though it is likely that the sampling probability is still highly dependant on fishing frequency so that the assumption does hold in an approximate sense. The validity of this assumption also impacts the interpretation of percentiles reported by Price et al. (1994) since inverse frequency was used as sampling weights. It is likely that the value (2.9 g/day) of Price et al. (1994) underestimates somewhat the median intake in the target population, but is much closer to the actual value than the Puffer et al. (1981) estimate of 37.3 g/day. Similar statements would apply about the 90th percentile. Similarly, the 37.3 g/day median value, if interpreted as the 50th percentile of the "resource utilization distribution", is also somewhat of an underestimate.

It should be noted again that the fish intake distribution generated by Puffer et al. (1981) (and by Price et al., 1994) was based only on fishermen who caught fish and ate the fish they caught. If all anglers were included, intake estimates would be somewhat lower. In contrast, the survey assumed that the number of fish caught at the time of the interview was all that would be caught that day. If it were possible to interview fishermen at the conclusion of their fishing day, intake estimates could be potentially higher. An additional factor potentially affecting intake rates is that fishing quarantines were imposed in early spring due to heavy sewage overflow (Puffer et al., 1981).

Pierce et al. (1981) - Commencement Bay Seafood Consumption Study - Pierce et al. (1981) performed a local creel survey to examine seafood consumption patterns and demographics of sport fishermen in Commencement Bay, Washington. The objectives of this survey included determining (1) seafood consumption habits and demographics of non-commercial anglers catching seafood; (2) the extent to which resident fish were used as food; and (3) the method of preparation of the fish to be consumed. Salmon were excluded from the survey since it was believed that they had little potential for contamination. The first half of this survey was conducted from early July to mid-September, 1980 and the second half from mid-September through most of November. During the summer months, interviewers visited each of 4 sub-areas of Commencement Bay on five mornings and five evenings; in the fall the areas were sampled 4 complete survey days. Interviews were conducted only with persons who had caught fish. The anglers were interviewed only once during the survey period. Data were recorded for species, wet weight, size of the living group (family, place of residence, fishing frequency, planned uses of the fish, age, sex, and race (Pierce et al., 1981). The analysis of Pierce et al. (1981) did not employ explicit sampling weights (i.e., all weights were set to 1).

There were 304 interviews in the summer and 204 in the fall. About 60 percent of anglers were white, 20 percent black, 19 percent Oriental and the rest Hispanic or Native American. Table 10-26 gives the distribution of fishing frequency calculated by Pierce et al. (1981); for both the summer and fall, more than half of the fishermen caught and consumed fish weekly. The dominant (by weight) species caught were Pacific Hake and Walleye Pollock. Pierce et al. (1981) did not present a distribution of fish intake or a mean fish intake rate.

The U.S. EPA (1989a) used the Pierce et al. (1981) fishing frequency distribution and an estimate of the average amount of fish consumed per angling trip to create an approximate intake distribution for the Pierce et al. (1981) survey. The estimate of the amount of fish consumed per angling trip (380 g/person-trip) was based on data on mean fish catch weight and mean number of consumers reported in Pierce et. al. (1981) and on an edible fraction of 0.5. U.S. EPA (1989a) reported a median intake rate of 23 g/day.

Price et al. (1994) obtained the raw data from this survey and performed a re-analysis using sampling weights proportional to inverse fishing frequency. The rationale for these weights is explained in Section 10.1 and in the discussion above of the Puffer et al. (1981) study. In the re-analysis, Price et al. (1994) found a median intake rate of 1.0 g/day and a 90th percentile rate of 13 g/day. The distribution of fishing frequency generated by Price et al. (1994) is shown in Table 10-27. Note that when equal weights were used, Price et al. (1994) found a median rate of 19 g/day, which was close to the approximate U.S. EPA (1989a) value reported above of 23 g/day.

The same limitations apply to interpreting the results presented here to those presented above in the

discussion of Puffer et al. (1981). The median intake rate found by Price et al. (1994) (using inverse frequency weights) is more reflective of median intake in the target population than is the value of 19 g/day (or 23 g/day); the latter value reflects more the 50th percentile of the resource utilization distribution, (i.e., that anglers with intakes above 19 g/day consume 50 percent of the recreational fish catch). Similarly, the fishing frequency distribution generated by Price et al. (1994) is more reflective of the fishing frequency distribution in the target population than is the distribution presented in Pierce et al. (1981). Note the target population is those anglers who fished at Commencement Bay during the time period of the survey.

As with the Puffer et al. (1981) data, these values (1.0 g/day and 19 g/day) are both probably underestimates since the sampling probabilities are less than proportional to fishing frequency; thus, the true target population median is probably somewhat above 1.0 g/day and the true 50th percentile of the resource utilization distribution is probably somewhat higher than 19 g/day. The data from this survey provide an indication of consumption patterns for the time period around 1980 in the Commencement Bay area. However, the data may not reflect current consumption patterns because fishing advisories were instituted due to local contamination.

U.S. DHHS (1995) - Health Study to Assess the Human Health Effects of Mercury Exposure to Fish Consumed from the Everglades - A health study was conducted in two phases in the Everglades, Florida for the U.S. Department of Health and Human Services (U.S. DHHS, 1995). The objectives of the first phase were to: (a) describe the human populations at risk for mercury exposure through their consumption of fish and other contaminated animals from the Everglades and (b) evaluate the extent of mercury exposure in those persons consuming contaminated food and their compliance with the voluntary health advisory. The second phase of the study involved neurologic testing of all study participants who had total mercury levels in hair greater than 7.5 μg/g. Study participants were identified by using special targeted screenings, mailings to residents, postings and multi-media advertisements of the study throughout the Everglades region, and direct discussions with people fishing along the canals and waterways in the contaminated areas. The contaminated areas were identified by the interviewers and long-term Everglade residents. Of a total of 1,794 individuals sampled, 405 individuals were eligible to participate in the study because they had consumed fish or wildlife from the Everglades at least once per month in the last 3 months of the study period. The majority of the eligible participants (> 93 percent) were either subsistence fishermen, Everglade residents, or both. Of the total eligible participants, 55 individuals refused to participate in the survey. Useable data were obtained from 330 respondents ranging in age from 10-81 years of age (mean age 39 years ± 18.8) (U.S. DHHS, 1995). Respondents were administered a three page questionnaire from which demographic information, fishing and eating habits, and other variables were obtained (U.S. DHHS, 1995).

Table 10-28 shows the ranges, means, and standard deviations of selected characteristics by subgroups of the survey population. Sixty-two percent of the respondents were male with a slight preponderance of black individuals (43 percent white, 46 percent black non-Hispanic, and 11 percent Hispanic) (Table 10-28). Most of the respondents reported earning an annual income of $15,000 or less per family before taxes (U.S. DHHS, 1995). The mean number of years fished along the canals by the respondents was 15.8 years with a standard deviation of 15.8. The mean number of times per week fish consumers reported eating fish over the last 6 months and last month of the survey period was 1.8 and 1.5 per week with a standard deviation of 2.5 and 1.4, respectively (Table 10-28). Table 10-28 also indicates that 71 percent of the respondents reported knowing about the mercury health advisories. Of those who were aware, 26 percent reported that they had lowered their consumption of fish caught in the Everglades while the rest (74 percent) reported no change in consumption patterns (U.S. DHHS, 1995).

A limitation of this study is that fish intake rates (g/day) were not reported. Another limitation is that the survey was site limited, and, therefore, not representative of the U.S. population. An advantage of this study is that it is one of the few studies targeting subsistence fishermen.

10.6. KEY FRESHWATER RECREATIONAL STUDIES

West et al. (1989) - Michigan Sport Anglers Fish Consumption Survey, 1989 - surveyed a stratified random sample of Michigan residents with fishing licences. The sample was divided into 18 cohorts, with one cohort receiving a mail questionnaire each week between January and May 1989. The survey included both a short term recall component recording respondents' fish intake over

a seven day period and a usual frequency component. For the short-term component, respondents were asked to identify all household members and list all fish meals consumed by each household member during the past seven days. The source of the fish for each meal was requested (self-caught, gift, market, or restaurant). Respondents were asked to categorize serving size by comparison with pictures of 8 oz. fish portions; serving sizes could be designated as either "about the same size", "less", or "more" than the 8 oz. picture. Data on fish species, locations of self-caught fish and methods of preparation and cooking were also obtained.

The usual frequency component of the survey asked about the frequency of fish meals during each of the four seasons and requested respondents to give the overall percentage of household fish meals that come from recreational sources. A sample of 2,600 individuals were selected from state records to receive survey questionnaires. A total of 2,334 survey questionnaires were deliverable and 1,104 were completed and returned, giving a response rate of 47.3 percent among individuals receiving questionnaires.

In the analysis of the survey data by West et. al. (1989), the authors did not attempt to generate the distribution of recreationally caught fish intake in the survey population. EPA obtained the raw data of this survey for the purpose of generating fish intake distributions and other specialized analyses.

As described elsewhere in this handbook, percentiles of the distribution of average daily intake reflective of long-term consumption patterns can not in general be estimated using short-term (e.g., one week) data. Such data can be used to estimate mean average daily intake rates (reflective of short or long term consumption); in addition, short term data can serve to validate estimates of usual intake based on longer recall.

EPA first analyzed the short term data with the intent of estimating mean fish intake rates. In order to compare these results with those based on usual intake, only respondents with information on both short term and usual intake were included in this analysis. For the analysis of the short term data, EPA modified the serving size weights used by West et al. (1989), which were 5, 8 and 10 oz., respectively, for portions that were less, about the same, and more than the 8 oz. picture. EPA examined the percentiles of the distribution of fish meal sizes reported in Pao et al. (1982) derived from the 1977-1978 USDA National Food Consumption Survey and observed that a lognormal distribution provided a good visual fit to the percentile data. Using this lognormal distribution, the mean values for serving sizes greater than 8 oz. and for serving sizes at least 10 percent greater than 8 oz. were determined. In both cases a serving size of 12 oz. was consistent with the Pao et al. (1982) distribution. The weights used in the EPA analysis then were 5, 8, and 12 oz. for fish meals described as less, about the same, and more than the 8 oz. picture, respectively. It should be noted that the mean serving size from Pao et al. (1982) was about 5 oz., well below the value of 8 oz. most commonly reported by respondents in the West et al. (1989) survey.

Table 10-29 displays the mean number of total and recreational fish meals for each household member based on the seven day recall data. Also shown are mean fish intake rates derived by applying the weights described above to each fish meal. Intake was calculated on both a grams/day and grams/kg body weight/day basis. This analysis was restricted to individuals who eat fish and who reside in households reporting some recreational fish consumption during the previous year. About 75 percent of survey respondents (i.e., licensed anglers) and about 84 percent of respondents who fished in the prior year reported some household recreational fish consumption.

The EPA analysis next attempted to use the short term data to validate the usual intake data. West et al. (1989) asked the main respondent in each household to provide estimates of their usual frequency of fishing and eating fish, by season, during the previous year. The survey provides a series of frequency categories for each season and the respondent was asked to check the appropriate range. The ranges used for all questions were: almost daily, 2-4 times a week, once a week, 2-3 times a month, once a month, less often, none, and don't know. For quantitative analysis of the data it is necessary to convert this categorical information into numerical frequency values. As some of the ranges are relatively broad, the choice of conversion values can have some effect on intake estimates. In order to obtain optimal values, the usual fish eating frequency reported by respondents for the season during which the questionnaire was completed was compared to the number of fish meals reportedly consumed by respondents over the seven day short-term recall period. The results of these comparisons are displayed in Table 10-30; it shows that, on average, there is general agreement between estimates made using one year recall and estimates based on seven day recall. The average number of meals (1.96/week) was at the bottom of the range for the most frequent consumption

group with data (2-4 meals/week). In contrast, for the lower usual frequency categories, the average number of meals was at the top, or exceeded the top of category range. This suggests some tendency for relatively infrequent fish eaters to underestimate their usual frequency of fish consumption. The last column of the table shows the estimated fish eating frequency per week that was selected for use in making quantitative estimates of usual fish intake. These values were guided by the values in the second column, except that frequency values that were inconsistent with the ranges provided to respondents in the survey were avoided.

Using the four seasonal fish eating frequencies provided by respondents and the above conversions for reported intake frequency, EPA estimated the average number of fish meals per week for each respondent. This estimate, as well as the analysis above, pertain to the total number of fish meals eaten (in Michigan) regardless of the source of the fish. Respondents were not asked to provide a seasonal breakdown for eating frequency of recreationally caught fish; rather, they provided an overall estimate for the past year of the percent of fish they ate that was obtained from different sources. EPA estimated the annual frequency of recreationally caught fish meals by multiplying the estimated total number of fish meals by the reported percent of fish meals obtained from recreational sources; recreational sources were defined as either self caught or a gift from family or friends.

The usual intake component of the survey did not include questions about the usual portion size for fish meals. In order to estimate usual fish intake, a portion size of 8 oz. was applied (the majority of respondents reported this meal size in the 7 day recall data). Individual body weight data were used to estimate intake on a g/kg-day basis. The fish intake distribution estimated by EPA is displayed in Table 10-31.

The distribution shown in Table 10-31 is based on respondents who consumed recreational caught fish. As mentioned above, these represent 75 percent of all respondents and 84 percent of respondents who reported having fished in the prior year. Among this latter population, the mean recreational fish intake rate is 14.4*0.84=12.1 g/day; the value of 38.7 g/day (95th percentile among consumers) corresponds to the 95.8th percentile of the fish intake distribution in this (fishing) population.

The advantages of this data set and analysis are that the survey was relatively large and contained both short-term and usual intake data. The presence of short term data allowed validation of the usual intake data which was based on long term recall; thus, some of the problems associated with surveys relying on long term recall are mitigated here.

The response rate of this survey, 47 percent, was relatively low. In addition, the usual fish intake distribution generated here employed a constant fish meal size, 8 oz.. Although use of this value as an average meal size was validated by the short-term recall results, the use of a constant meal size, even if correct on average, may seriously reduce the variation in the estimated fish intake distribution.

This study was conducted in the winter and spring months of 1988. This period does not include the summer months when peak fishing activity can be anticipated, leading to the possibility that intake results based on the 7 day recall data may understate individuals' usual (annual average) fish consumption. A second survey by West et al. (1993) gathered diary data on fish intake for respondents spaced over a full year. However, this later survey did not include questions about usual fish intake and has not been reanalyzed here. The mean recreational fish intake rates derived from the short term and usual components were quite similar, however, 14.0 versus 14.4 g/day.

Chemrisk (1991) - Consumption of Freshwater Fish by Maine Anglers - Chemrisk conducted a study to characterize the rates of freshwater fish consumption among Maine residents (Chemrisk, 1991; Ebert et al., 1993). Since the only dietary source of local freshwater fish is recreational fish, the anglers in Maine were chosen as the survey population. The survey was designed to gather information on the consumption of fish caught by anglers from flowing (rivers and streams) and standing (lakes and ponds) water bodies. Respondents were asked to recall the frequency of fishing trips during the 1989-1990 ice-fishing season and the 1990 open water season, the number of fish species caught during both seasons, and estimate the number of fish consumed from 15 fish species. The respondents were also asked to describe the number, species, and average length of each sport-caught fish consumed that had been gifts from other members of their households or other household. The weight of fish consumed by anglers was calculated by first multiplying the estimated weight of the fish by the edible fraction, and then dividing this product by the number of intended consumers. Species specific regression equations were utilized to estimate weight from the reported fish length.

The edible fractions used were 0.4 for salmon, 0.78 for Atlantic smelt, and 0.3 for all other species (Ebert et al., 1993).

A total of 2,500 prospective survey participants were randomly selected from a list of anglers licensed in Maine. The surveys were mailed in during October, 1990. Since this was before the end of the open fishing season, respondents were also asked to predict how many more open water fishing trips they would undertake in 1990.

Chemrisk (1991) and Ebert et al. (1993) calculated distributions of freshwater fish intake for two populations, "all anglers" and "consuming anglers". All anglers were defined as licensed anglers who fished during either the 1989-1990 ice-fishing season or the 1990 open-water season (consumers and non-consumers) and licensed anglers who did not fish but consumed freshwater fish caught in Maine during these seasons. "Consuming anglers" were defined as those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season. In addition, the distribution of fish intake from rivers and streams was also calculated for two populations, those fishing on rivers and streams ("river anglers") and those consuming fish from rivers and streams ("consuming river anglers").

A total of 1,612 surveys were returned, giving a response rate of 64 percent; 1,369 (85 percent) of the 1,612 respondents were included in the "all angler" population and 1,053 (65 percent) were included in the "consuming angler" population. Freshwater fish intake distributions for these populations are presented in Table 10-32. The mean and 95th percentile was 5.0 g/day and 21.0 g/day, respectively, for " all anglers," and 6.4 g/day and 26.0 g/day, respectively, for "consuming anglers." Table 10-32 also presents intake distributions for fish caught from rivers and streams. Among "river anglers" the mean and 95th percentiles were 1.9 g/day and 6.2 g/day, respectively, while among "consuming river anglers" the mean was 3.7 g/day and the 95th percentile was 12.0 g/day. Table 10-33 presents fish intake distributions by ethnic group for consuming anglers. The highest mean intake rates reported are for Native Americans (10 g/day) and French Canadians (7.4 g/day). Because there was a low number of respondents for Hispanics, Asian/Pacific Islanders, and African Americans, intake rates within these subgroups were not calculated (Chemrisk, 1991).

The consumption, by species, of freshwater fish caught is presented in Table 10-34. The largest specie consumption was salmon from ice fishing (~292,000 grams); white perch (380,000 grams) for lakes and ponds; and Brooktrout (420,000 grams) for rivers and streams (Chemrisk, 1991).

EPA obtained the raw data tapes from the marine anglers survey and performed some specialized analyses. One analysis involved examining the percentiles of the "resource utilization distribution" (this distribution was defined in Section 10.1). The 50th, or more generally the pth percentile of the resource utilization distribution, is defined as the consumption level such that p percent of the resource is consumed by individuals with consumptions below this level and 100-p percent by individuals with consumptions above this level. EPA found that 90 percent of recreational fish consumption was by individuals with intake rates above 3.1 g/day and 50 percent was by individuals with intakes above 20 g/day. Those above 3.1 g/day make up about 30 percent of the "all angler" population and those above 20 g/day make up about 5 percent of this population; thus, the top 5 percent of the angler population consumed 50 percent of the recreational fish catch.

EPA also performed an analysis of fish consumption among anglers and their families. This analysis was possible because the survey included questions on the number, sex, and age of each individual in the household and whether the individual consumed recreationally caught fish. The total population of licensed anglers in this survey and their household members was 4,872; the average household size for the 1,612 anglers in the survey was thus 3.0 persons. Fifty-six percent of the population was male and 30 percent was 18 or under.

A total of 55 percent of this population was reported to consume freshwater recreationally caught fish in the year of the survey. The sex and ethnic distribution of the consumers was similar to that of the overall population. The distribution of fish intake among the overall household population, or among consumers in the household, can be calculated under the assumption that recreationally caught fish was shared equally among all members of the household reporting consumption of such fish (note this assumption was used above to calculate intake rates for anglers). With this assumption, the mean intake rate among consumers was 5.9 g/day with a median of 1.8 g/day and a 95th percentile of 23.1 g/day; for the overall population the mean was 3.2 g/day and the 95th percentile was 14.1 g/day.

The results of this survey can be put into the context of the overall Maine population. The 1,612

anglers surveyed represent about 0.7 percent of the estimated 225,000 licensed anglers in Maine. It is reasonable to assume that licensed anglers and their families will have the highest exposure to recreationally caught freshwater fish. Thus, to estimate the number of persons in Maine with recreationally caught freshwater fish intake above, for instance, 6.5 g/day (the 80th percentile among household consumers in this survey), one can assume that virtually all persons came from the population of licensed anglers and their families. The number of persons above 6.5 g/day in the household survey population is calculated by taking 20 percent (i.e., 100 percent - 80 percent) of the consuming population in the survey; this number then is 0.2*(0.55*4872)=536. Dividing this number by the sampling fraction of 0.007 (0.7 percent) gives about 77,000 persons above 6.5 g/day of recreational freshwater fish consumption statewide. The 1990 census showed the population of Maine to be 1.2 million people; thus the 77,000 persons above 6.5 g/day represent about 6 percent of the state's population.

Chemrisk (1991) reported that the fish consumption estimates obtained from the survey were conservative because of assumptions made in the analysis. The assumptions included: a 40 percent estimate as the edible portion of landlocked and Atlantic salmon; inclusion of the intended number of future fishing trips and an assumption that the average success and consumption rates for the individual angler during the trips already taken would continue through future trips. The data collected for this study were based on recall and self-reporting which may have resulted in a biased estimate. The social desirability of the sport and frequency of fishing are also bias contributing factors; successful anglers are among the highest consumers of freshwater fish (Chemrisk, 1991). Over reporting appears to be correlated with skill level and the importance of the activity to the individual; it is likely that the higher consumption rates may be substantially overstated (Chemrisk, 1991). Additionally, fish advisories are in place in these areas and may affect the rate of fish consumption among anglers. The survey results showed that in 1990, 23 percent of all anglers consumed no freshwater fish, and 55 percent of the river anglers ate no freshwater fish. An advantage of this study is that it presents area-specific consumption patterns and the sample size is rather large.

West et al. (1993) - Michigan Sport Anglers Fish Consumption Study, 1991-1992 - This survey, financed by the Michigan Great Lakes Protection Fund, was a follow-up to the earlier 1989 Michigan survey described previously. The major purpose of 1991-1992 survey was to provide short-term recall data of recreational fish consumption over a full year period; the 1989 survey, in contrast, was conducted over only a half year period (West et al., 1993).

This survey was similar in design to the 1989 Michigan survey. A sample of 7,000 persons with Michigan fishing licenses was drawn and surveys were mailed in 2-week cohorts over the period January, 1991 to January, 1992. Respondents were asked to report detailed fish consumption patterns during the preceding seven days, as well as demographic information; they were also asked if they currently eat fish. Enclosed with the survey were pictures of about a half pound of fish. Respondents were asked to indicate whether reported consumption at each meal was more, less or about the same as the picture. Based on responses to this question, respondents were assumed to have consumed 10, 5 or 8 ounces of fish, respectively.

A total of 2,681 surveys were returned. West et al. (1993) calculated a response rate for the survey of 46.8 percent; this was derived by removing from the sample those respondents who could not be located or who did not reside in Michigan for at least six months.

Of these 2,681 respondents, 2,475 (93 percent) reported that they currently eat fish; all subsequent analyses were restricted to the current fish eaters. The mean fish consumption rates were found to be 16.7 g/day for sport fish and 26.5 g/day for total fish (West et al., 1993). Table 10-35 shows mean sport-fish consumption rates by demographic categories. Rates were higher among minorities, people with low income, and people residing in smaller communities. Consumption rates in g/day were also higher in males than in females; however, this difference would likely disappear if rates were computed on a g/kg-day basis.

West et al. (1993) estimated the 80th percentile of the survey fish consumption distribution. More extensive percentile calculations were performed by U.S. EPA (1995) using the raw data from the West et al. (1993) survey and calculated 50th, 90th, and 95th percentiles. However, since this survey only measured fish consumption over a short (one week) interval, the resulting distribution will not be indicative of the long-term fish consumption distribution and the upper percentiles reported from the EPA analysis will likely considerably overestimate the corresponding long term percentiles. The overall 95th percentile calculated by

U.S. EPA (1995) was 77.9; this is about double the 95th percentile estimated using year long consumption data from the 1989 Michigan survey.

The limitations of this survey are the relatively low response rate and the fact that only three categories were used to assign fish portion size. The main study strengths were its relatively large size and its reliance on short-term recall.

Connelly et al. (1996) - Sportfish Consumption Patterns of Lake Ontario Anglers and the Relationship to Health Advisories, 1992 - The objectives of this study were to provide accurate estimates of fish consumption (overall and sport caught) among Lake Ontario anglers and to evaluate the effect of Lake Ontario health advisory recommendations (Connelly et al., 1996). To target Lake Ontario anglers, a sample of 2,500 names was randomly drawn from 1990-1991 New York fishing license records for licenses purchased in six counties bordering Lake Ontario. Participation in the study was solicited by mail with potential participants encouraged to enroll in the study even if they fished infrequently or consumed little or no sport caught fish. The survey design involved three survey techniques including a mail questionnaire asking for 12 month recall of 1991 fishing trips and fish consumption, self-recording information in a diary for 1992 fishing trips and fish consumption, periodic telephone interviews to gather information recorded in the diary and a final telephone interview to determine awareness of health advisories (Connelly et al., 1996).

Participants were instructed to record in the diary the species of fish eaten, meal size, method by which fish was acquired (sport-caught or other), fish preparation and cooking techniques used and the number of household members eating the meal. Fish meals were defined as finfish only. Meal size was estimated by participants by comparing their meal size to pictures of 8 oz. fish steaks and fillets on dinner plates. An 8 oz. size was assumed unless participants noted their meal size was smaller than 8 oz., in which case a 4 oz. size was assumed, or they noted it was larger than 8 oz., in which case a 12 oz. size was assumed. Participants were also asked to record information on fishing trips to Lake Ontario and species and length of any fish caught.

From the initial sample of 2,500 license buyers, 1,993 (80 percent) were reachable by phone or mail and 1,410 of these were eligible for the study, in that they intended to fish Lake Ontario in 1992. A total of 1,202 of these 1,410, or 85 percent, agreed to participate in the study. Of the 1,202 participants, 853 either returned the diary or provided diary information by telephone. Due to changes in health advisories for Lake Ontario which resulted in less Lake Ontario fishing in 1992, only 43 percent, or 366 of these 853 persons indicated that they fished Lake Ontario during 1992. The study analyses summarized below concerning fish consumption and Lake Ontario fishing participation are based on these 366 persons.

Anglers who fished Lake Ontario reported an average of 30.3 (S.E. = 2.3) fish meals per person from all sources in 1992; of these meals 28 percent were sport caught (Connelly et al., 1996). Less than 1 percent ate no fish for the year and 16 percent ate no sport caught fish. The mean fish intake rate from all sources was 17.9 g/day and from sport caught sources was 4.9 g/day. Table 10-36 gives the distribution of fish intake rates from all sources and from sport caught fish. The median rates were 14.1 g/day for all sources and 2.2 g/day for sport caught; the 95th percentiles were 42.3 g/day and 17.9 g/day for all sources and sport caught, respectively. As seen in Table 10-37, statistically significant differences in intake rates were seen across age and residence groups, with residents of large cities and younger people having lower intake rates on average.

The main advantage of this study is the diary format. This format provides more accurate information on fishing participation and fish consumption, than studies based on 1 year recall (Ebert et al., 1993). However, a considerable portion of diary respondents participated in the study for only a portion of the year and some errors may have been generated in extrapolating these respondents' results to the entire year (Connelly et al., 1996). In addition, the response rate for this study was relatively low, 853 of 1,410 eligible respondents, or 60 percent, which may have engendered some non-response bias.

The presence of health advisories should be taken into account when evaluating the intake rates observed in this study. Nearly all respondents (>95 percent) were aware of the Lake Ontario health advisory. This advisory counseled to eat none of 9 fish species from Lake Ontario and to eat no more than one meal per month of another 4 species. In addition, New York State issues a general advisory to eat no more than 52 sport caught fish meals per year. Among participants who fished Lake Ontario in 1992, 32 percent said they would eat more fish if health advisories did not exist. A significant fraction of respondents did not totally adhere to the fish advisory; however, 36 percent of respondents, and 72 percent of

respondents reporting Lake Ontario fish consumption, ate at least one species of fish over the advisory limit. Interestingly, 90 percent of those violating the advisory reported that they believed they were eating within advisory limits.

10.7. RELEVANT FRESHWATER RECREATIONAL STUDIES

Fiore et al. (1989) - Sport Fish Consumption and Body Burden Levels of Chlorinated Hydrocarbons: A Study of Wisconsin Anglers. This survey, reported by Fiore et al. (1989), was conducted to assess sociodemographic factors and sport fishing habits of anglers, to evaluate anglers' comprehension of and compliance with the Wisconsin Fish Consumption Advisory, to measure body burden levels of PCBs and DDE through analysis of blood serum samples and to examine the relationship between body burden levels and consumption of sport-caught fish. The survey targeted all Wisconsin residents who had purchased fishing or sporting licenses in 1984 in any of 10 pre-selected study counties. These counties were chosen in part based on their proximity to water bodies identified in Wisconsin fish advisories. A total of 1,600 anglers were sent survey questionnaires during the summer of 1985.

The survey questionnaire included questions about fishing history, locations fished, species targeted, kilograms caught for consumption, overall fish consumption (including commercially caught) and knowledge of fish advisories. The recall period was one year.

A total of 801 surveys were returned (50 percent response rate). Of these, 601 (75 percent) were from males and 200 from females; the mean age was 37 years. Fiore et al. (1989) reported that the mean number of fish meals for 1984 for all respondents was 18 for sport-caught meals and 24 for non-sport caught meals. Fiore et al. (1989) assumed that each fish meal consisted of 8 ounces (227 grams) of fish to generate means and percentiles of fish intake. The reported per-capita intake rate of sport-caught fish was 11.2 g/day; among consumers, who comprised 91 percent of all respondents, the mean sport-caught fish intake rate was 12.3 g/day and the 95th percentile was 37.3 g/day. The mean daily fish intake from all sources (both sport caught and commercial) was 26.1 g/day with a 95th percentile of 63.4 g/day. The 95th percentile of 37.3 g/day of sport caught fish represents 60 fish meals per year; 63.4 g/day (the 95th percentile of total fish intake) represents 102 fish meals per year.

Fiore et al. (1989) assumed a (constant) meal size of 8 ounces (227 grams) of fish which may over-estimate average meal size. Pao et al. (1982), using data from the 1977-78 USDA NFCS, reported an average fish meal size of slightly less than 150 grams for adult males. EPA obtained the raw data from this study and calculated the distribution of the number of sport-caught fish meals and the distribution of fish intake rates (using 150 grams/meal); these distributions are presented in Table 10-38. With this average meal size, the per-capita estimate is 7.4 g/day.

This study is limited in its ability to accurately estimate intake rates because of the absence of data on weight of fish consumed. Another limitation of this study is that the results are based on one year recall, which may tend to over-estimate the number of fishing trips (Ebert et al.,1993). In addition, the response rate was rather low (50 percent).

Connelly et al. (1992) - Effects of Health Advisory and Advisory Changes on Fishing Habits and Fish Consumption in New York Sport Fisheries - Connelly et al. (1992) conducted a study to assess the awareness and knowledge of New York anglers about fishing advisories and contaminants found in fish and their fishing and fish consuming behaviors. The survey sample consisted of 2,000 anglers with New York State fishing licenses for the year beginning October 1, 1990 through September 30, 1991. A questionnaire was mailed to the survey sample in January, 1992. The questionnaire was designed to measure catch and consumption of fish, as well as methods of fish preparation and knowledge of and attitudes towards health advisories (Connelly et al., 1992). The survey adjusted response rate was 52.8 percent (1,030 questionnaires were completed and 51 were not deliverable).

The average and median number of fishing days per year were 27 and 15 days respectively (Connelly et al. 1992). The mean number of sport-caught fish meals was 11. About 25 percent of anglers reported that they did not consume sport-caught fish.

Connelly et al. (1992) found that 80 percent of anglers statewide did not eat listed species or ate them within advisory limits and followed the 1 sport-caught fish meal per week recommended maximum. The other 20 percent of anglers exceeded the advisory recommendations in some way; 15 percent ate listed species above the limit and 5 percent ate more than one sport caught meal per week.

Connelly et al. (1992) found that respondents eating more than one sport-caught meal per week were just as likely as those eating less than one meal per week to know the recommended level of sport-caught fish consumption, although less than 1/3 in each group knew the level. An estimated 85 percent of anglers were aware of the health advisory. Over 50 percent of respondents said that they made changes in their fishing or fish consumption behaviors in response to health advisories.

The advisory included a section on methods that can be used to reduce contaminant exposure. Respondents were asked what methods they used for fish cleaning and cooking. Summary results on preparation and cooking methods are presented in Section 10.9 and in Appendix 10B.

A limitation of this study with respect to estimating fish intake rates is that only the number of sport-caught meals was ascertained, not the weight of fish consumed. The fish meal data can be converted to an intake rate (g/day) by assuming a value for a fish meal such as that from Pao et al. (1982) (about 150 grams as the average amount of fish consumed per eating occasion for adult males - males comprised 88 percent of respondents in the current study). Using 150 grams/meal the mean intake rate among the angler population would be 4.5 g/day; note that about 25 percent of this population reported no sport-caught fish consumption.

The major focus of this study was not on consumption, per se, but on the knowledge of and impact of fish health advisories; Connelly et al. (1992) provides important information on these issues.

Hudson River Sloop Clearwater, Inc. (1993) - Hudson River Angler Survey - Hudson River Sloop Clearwater, Inc. (1993) conducted a survey of adherence to fish consumption health advisories among Hudson River anglers. All fishing has been banned on the upper Hudson River where high levels of PCB contamination are well documented; while voluntary recreational fish consumption advisories have been issued for areas south of the Troy Dam (Hudson River Sloop Clearwater, Inc., 1993).

The survey consisted of direct interviews with 336 shore-based anglers between the months of June and November 1991, and April and July 1992. Socio-demographic characteristics of the respondents are presented in Table 10-39. The survey sites were selected based on observations of use by anglers, and legal accessibility. The selected sites included upper, mid-, and lower Hudson River sites located in both rural and urban settings. The interviews were conducted on weekends and weekdays during morning, midday, and evening periods. The anglers were asked specific questions concerning: fishing and fish consumption habits; perceptions of presence of contaminants in fish; perceptions of risks associated with consumption of recreationally caught fish; and awareness of, attitude toward, and response to fish consumption advisories or fishing bans.

Approximately 92 percent of the survey respondents were male. The following statistics were provided by Hudson River Sloop Clearwater, Inc. (1993). The most common reason given for fishing was for recreation or enjoyment. Over 58 percent of those surveyed indicated that they eat their catch. Of those anglers who eat their catch, 48 percent reported being aware of advisories. Approximately 24 percent of those who said they currently do not eat their catch, have done so in the past. Anglers were more likely to eat their catch from the lower Hudson areas where health advisories, rather than fishing bans, have been issued. Approximately 94 percent of Hispanic Americans were likely to eat their catch, while 77 percent of African Americans and 47 percent of Caucasian Americans intended to eat their catch. Of those who eat their catch, 87 percent were likely to share their meal with others (including women of childbearing age, and children under the age of fifteen).

For subsistence anglers, more low-income than upper income anglers eat their catch (Hudson River Sloop Clearwater, Inc., 1993). Approximately 10 percent of the respondents stated that food was their primary reason for fishing; this group is more likely to be in the lowest per capita income group (Hudson River Sloop Clearwater, Inc., 1993).

The average frequency of fish consumption reported was just under one (0.9) meal over the previous week, and three meals over the previous month. Approximately 35 percent of all anglers who eat their catch exceeded the amounts recommended by the New York State health advisories. Less than half (48 percent) of all the anglers interviewed were aware of the State health advisories or fishing bans. Only 42 percent of those anglers aware of the advisories have changed their fishing habits as a result.

The advantages of this study include: in-person interviews with 95 percent of all anglers approached; field-tested questions designed to minimize interviewer bias; and candid responses concerning consumption of fish from contaminated waters. The limitations of this

study are that specific intake amounts are not indicated, and that only shore-based anglers were interviewed.

10.8. NATIVE AMERICAN FRESHWATER STUDIES

Wolfe and Walker (1987) - Subsistence Economies in Alaska: Productivity, Geography, and Development Impacts - Wolfe and Walker (1987) analyzed a dataset from 98 communities for harvests of fish, land mammals, marine mammals, and other wild resources. The analysis was performed to evaluate the distribution and productivity of subsistence harvests in Alaska during the 1980s. Harvest levels were used as a measure of productivity. Wolfe and Walker (1987) defined harvest to represent a single year's production from a complete seasonal round. The harvest levels were derived primarily from a compilation of data from subsistence studies conducted between 1980 to 1985 by various researchers in the Alaska Department of Fish and Game, Division of Subsistence.

Of the 98 communities studied, four were large urban population centers and 94 were small communities. The harvests for these latter 94 communities were documented through detailed retrospective interviews with harvesters from a sample of households (Wolfe and Walker, 1987). Harvesters were asked to estimate the quantities of a particular species that were harvested and used by members of that household during the previous 12-month period. Wolfe and Walker (1987) converted harvests to a common unit for comparison, pounds dressed weight per capita per year, by multiplying the harvests of households within each community by standard factors converting total pounds to dressed weight, summing across households, and then dividing by the total number of household members in the household sample. Dressed weight varied by species and community but in general was 70 to 75 percent of total fish weight; dressed weight for fish represents that portion brought into the kitchen for use (Wolfe and Walker, 1987).

Harvests for the four urban populations were developed from a statewide data set gathered by the Alaska Department of Fish and Game Divisions of Game and Sports Fish. Urban sport fish harvest estimates were derived from a survey that was mailed to a randomly selected statewide sample of anglers (Wolfe and Walker, 1987). Sport fish harvests were disaggregated by urban residency and the dataset was analyzed by converting the harvests into pounds and dividing by the 1983 urban population.

For the overall analysis, each of the 98 communities was treated as a single unit of analysis and the entire group of communities was assumed to be a sample of all communities in Alaska (Wolfe and Walker, 1987). Each community was given equal weight, regardless of population size. Annual per capita harvests were calculated for each community. For the four urban centers, fish harvests ranged from 5 to 21 pounds per capita per year (6.2 g/day to 26.2 g/day).

The range for the 94 small communities was 25 to 1,239 pounds per capita per year (31 g/day to 1,541 g/day). For these 94 communities, the median per capita fish harvest was 130 pounds per year (162 g/day). In most (68 percent) of the 98 communities analyzed, resource harvests for fish were greater than the harvests of the other wildlife categories (land mammal, marine mammal, and other) combined.

The communities in this study were not made up entirely of Alaska Natives. For roughly half the communities, Alaska Natives comprised 80 percent or more of the population, but for about 40 percent of the communities they comprised less than 50 percent of the population. Wolfe and Walker (1987) performed a regression analysis which showed that the per capita harvest of a community tended to increase as a function of the percentage of Alaska Natives in the community. Although this analysis was done for total harvest (i.e., fish, land mammal, marine mammal and others) the same result should hold for fish harvest since fish harvest is highly correlated with total harvest.

A limitation of this report is that it presents (per-capita) harvest rates as opposed to individual intake rates. Wolfe and Walker (1987) compared the per capita harvest rates reported to the results for the household component of the 1977-1978 USDA National Food Consumption Survey (NFCS). The NFCS showed that about 222 pounds of meat, fish, and poultry were purchased and brought into the household kitchen for each person each year in the western region of the United States. This contrasts with a median total resource harvest of 260 lbs/yr in the 94 communities studied. This comparison, and the fact that Wolfe and Walker (1987) state that "harvests represent that portion brought into the kitchen for use," suggest that the same factors used to convert household consumption rates in the NFCS to individual intake rates can be used to convert per capita harvest rates to individual intake rates. In Section 10.3, a factor of 0.5 was used to convert fish consumption from household to individual intake rates. Applying this factor, the median

per capita individual fish intake in the 94 communities would be 81 g/day and the range 15.5 to 770 g/day.

A limitation of this study is that the data were based on 1-year recall from a mailed survey. An advantage of the study is that it is one of the few studies that present fish harvest patterns for subsistence populations.

AIHC (1994) - Exposure Factors Sourcebook - The Exposure Factors Sourcebook (AIHC, 1994) provides data for non-marine fish intake consistent with this document. However, the total fish intake rate recommended in AIHC (1994) is approximately 40 percent lower than that in this document. The fish intake rates presented in this handbook are based on more recent data from USDA CSFII (1989-1991). AIHC (1994) presents probability distributions in grams fish per kilogram of body weight for fish consumption based on data from U.S. EPA Guidance Manual, Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish (U.S. EPA, 1989b). The @Risk formula is provided for direct use in the @Risk simulation software. The @Risk formula was provided for the distributions that were provided for the ingestion of freshwater finfish, saltwater finfish, and fish (unspecified) in the U.S. general population, children ages 1 to 6 years, and males ages 13 years and above. Distributions were also provided for saltwater finfish ingestion in the general population and for females and for males 13 years of age and older. Distributions for shellfish ingestion were provided for the general population, children ages 1 to 6 years, and for males and females 13 years of age and above. Additionally, distributions for "unspecified" fish ingestion were presented for the above mentioned populations.

The Sourcebook has been classified as a relevant rather than key study because it was not the primary source for the data used to make recommendations in this document. The Sourcebook is very similar to this document in the sense that it summarizes exposure factor data and recommends values. Therefore, it can be used as an alternative information source on fish intake.

Columbia River Inter-Tribal Fish Commission (CRITFC) (1994) - A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin - CRITFC (1994) conducted a fish consumption survey among four Columbia River Basin Indian tribes during the fall and winter of 1991-1992. The target population included all adult tribal members who lived on or near the Yakama, Warm Springs, Umatilla or Nez Perce reservations. The survey was based on a stratified random sampling design where respondents were selected from patient registration files at the Indian Health Service. Interviews were performed in person at a central location on the member's reservation.

Information requested included annual and seasonal numbers of fish meals, average serving size per fish meal, species and part(s) of fish consumed, preparation methods, changes in patterns of consumption over the last 20 years and during ceremonies and festivals, breast feeding practices and 24 hour dietary recall (CRITFC, 1994). Foam sponge food models approximating four, eight, and twelve ounce fish fillets were provided to help respondents estimate average fish meal size. Fish intake rates were calculated by multiplying the annual frequency of fish meals by the average serving size per fish meal.

The study was designed to give essentially equal sample sizes for each tribe. However, since the population sizes of the tribes were highly unequal, it was necessary to weight the data (in proportion to tribal population size) in order that the survey results represent the overall population of the four tribes. Such weights were applied to the analysis of adults; however, because the sample size for children was considered small, only an unweighted analysis was performed for this population (CRITFC, 1994).

The survey respondents consisted of 513 tribal members, 18 years old and above. Of these, 58 percent were female and 59 percent were under 40 years old. In addition, information for 204 children 5 years old and less was provided by the participating adult respondent. The overall response rate was 69 percent.

The results of the survey showed that adults consumed an average of 1.71 fish meals/week and had an average intake of 58.7 grams/day (CRITFC, 1994). Table 10-40 shows the adult fish intake distribution; the median was between 29 and 32 g/day and the 95th percentile about 170 g/day. A small percentage (7 percent) of respondents indicated that they were not fish consumers. Table 10-41 shows that mean intake was slightly higher in males than females (63 g/d versus 56 g/d) and was higher in the over 60 years age group (74.4 g/d) than in the 18-39 years (57.6 g/d) or 40-59 years (55.8 g/d) age groups. Intake also tended to be higher among those living on the reservation. The mean intake for nursing mothers, 59.1 g/d, was similar to the overall mean intake.

A total of 49 percent of respondents reported that they caught fish from the Columbia River basin and its

tributaries for personal use or for tribal ceremonies and distributions to other tribe members and 88 percent reported that they obtained fish from either self-harvesting, family or friends, at tribal ceremonies or from tribal distributions. Of all fish consumed, 41 percent came from self or family harvesting, 11 percent from the harvest of friends, 35 percent from tribal ceremonies or distribution, 9 percent from stores and 4 percent from other sources (CRITFC, 1994).

The analysis of seasonal intake showed that May and June tended to be high consumption months and December and January low consumption months. The mean adult intake rate for May and June was 108 g/d while the mean intake rate for December and January was 30.7 g/d. Salmon was the species eaten by the highest number of respondents (92 percent) followed by trout (70 percent), lamprey (54 percent), and smelt (52 percent). Table 10-42 gives the fish intake distribution for children under 5 years of age. The mean intake rate was 19.6 g/d and the 95th percentile was approximately 70 g/d.

The authors noted that some non-response bias may have occurred in the survey since respondents were more likely to live near the reservation and were more likely to be female than non-respondents. In addition, they hypothesized that non fish consumers may have been more likely to be non-respondents than fish consumers since non consumers may have thought their contribution to the survey would be meaningless; if such were the case, this study would overestimate the mean intake rate. It was also noted that the timing of the survey, which was conducted during low fish consumption months, may have led to underestimation of actual fish consumption; the authors conjectured that an individual may report higher annual consumption if interviewed during a relatively high consumption month and lower annual consumption if interviewed during a relatively low consumption month. Finally, with respect to children's intake, it was observed that some of the respondents provided the same information for their children as for themselves, thereby the reliability of some of these data is questioned.

Although the authors have noted these limitations, this study does present information on fish consumption patterns and habits for a Native American subpopulation. It should be noted that the number of surveys that address subsistence subpopulations is very limited.

Peterson et al. (1994) - Fish Consumption Patterns and Blood Mercury Levels in Wisconsin Chippewa Indians - Peterson et al. (1994) investigated the extent of exposure of methylmercury to Chippewa Indians living on a Northern Wisconsin reservation who consume fish caught in northern Wisconsin lakes. The lakes in northern Wisconsin are known to be contaminated with mercury and the Chippewa have a reputation for high fish consumption (Peterson et al., 1994). The Chippewa Indians fish by the traditional method of spearfishing. Spearfishing (for walleye) occurs for about two weeks each spring after the ice breaks, and although only a small number of tribal members participate in it, the spearfishing harvest is distributed widely within the tribe by an informal distribution network of family and friends and through traditional tribal feasts (Peterson et al., 1994).

Potential survey participants, 465 adults, 18 years of age and older, were randomly selected from the tribal registries (Peterson et al., 1994). Participants were asked to complete a questionnaire describing their routine fish consumption and, more extensively, their fish consumption during the two previous months. They were also asked to give a blood sample that would be tested for mercury content. The survey was carried out in May 1990. A follow-up survey was conducted for a random sample of 75 non-respondents (80 percent were reachable), and their demographic and fish consumption patterns were obtained. Peterson et al. (1994) reported that the non-respondents' socioeconomic and fish consumption were similar to the respondents.

A total of 175 of the original random sample (38 percent) participated in the study. In addition, 152 nonrandomly selected participants were surveyed and included in the data analysis; these participants were reported by Peterson et al. (1994) to have fish consumption rates similar to those of the randomly selected participants. Results from the survey showed that fish consumption varied seasonally, with 50 percent of the respondents reporting April and May (spearfishing season) as the highest fish consumption months (Peterson et al., 1994). Table 10-43 shows the number of fish meals consumed per week during the last 2 months (recent consumption) before the survey was conducted and during the respondents' peak consumption months grouped by gender, age, education, and employment level. During peak consumption months, males consumed more fish (1.9 meals per week) than females (1.5 meals per week), respondents under 35 years of age consumed more fish (1.8 meals per week) than respondents 35 years of age and over (1.6 meals per week), and the unemployed consumed more fish (1.9 meals per week) than the employed (1.6 meals per week). During the highest fish consumption season (April and May), 50 percent of respondents

reported eating one or less fish meals per week and only 2 percent reported daily fish consumption (Figures 10-1 and 10-2). A total of 72 percent of respondents reported Walleye consumption in the previous two months. Peterson et al. (1994) also reported that the mean number of fish meals usually consumed per week by the respondents was 1.2.

The mean fish consumption rate reported (1.2 fish meals per week, or 62.4 meals per year) in this survey was compared with the rate reported in a previous survey of Wisconsin anglers (Fiore et al., 1989) of 42 fish meals per year. These results indicate that the Chippewa Indians do not consume much more fish than the general Wisconsin angler population (Peterson et al., 1994). The differences in the two values may be attributed to differences in study methodology (Peterson et al., 1994). Note that this number (1.2 fish meals per week) includes fish from all sources. Peterson et al. (1994) noted that subsistence fishing, defined as fishing as a major food source, appears rare among the Chippewa. Using the recommended rate in this handbook of 129 g/meal as the average weight of fish consumed per fish meal in the general population, the rate reported here of 1.2 fish meals per week translates into a mean fish intake rate of 22 g/day in this population.

Fitzgerald et al. (1995) - Fish PCB Concentrations and Consumption Patterns Among Mohawk Women at Akwesasne - Akwesasne is a native American community of ten thousand plus persons located along the St. Lawrence River (Fitzgerald et al., 1995). The local food chain has been contaminated with PCBs and some species have levels that exceed the U.S. FDA tolerance limits for human consumption (Fitzgerald et al., 1995). Fitzgerald et al. (1995) conducted a recall study from 1986 to 1992 to determine the fish consumption patterns among nursing Mohawk women residing near three industrial sites. The study sample consisted of 97 Mohawk women and 154 nursing Caucasian controls. The Mohawk mothers were significantly younger (mean age 24.9) than the controls (mean age 26.4) and had significantly more years of education (mean 13.1 for Mohawks versus 12.4 for controls). A total of 97 out of 119 Mohawk nursing women responded, a response rate of 78 percent; 154 out of 287 control nursing Caucasian women responded, a response rate of 54 percent.

Potential participants were identified prior to, or shortly after, delivery. The interviews were conducted at home within one month postpartum and were structured to collect information for sociodemographics, vital statistics, use of medications, occupational and residential histories, behavioral patterns (cigarette smoking and alcohol consumption), drinking water source, diet, and fish preparation methods (Fitzgerald et al., 1995). The dietary data collected were based on recall for food intake during the index pregnancy, the year before the pregnancy, and more than one year before the pregnancy.

The dietary assessment involved the report by each participant on the consumption of various foods with emphasis on local species of fish and game (Fitzgerald et al., 1995). This method combined food frequency and dietary histories to estimate usual intake. Food frequency was evaluated with a checklist of foods for indicating the amount of consumption of a participant per week, month or year. Information gathered for the dietary history included duration of consumption, changes in the diet, and food preparation method.

Table 10-44 presents the number of local fish meals per year for both the Mohawk and control participants. The highest percentage of participants reported consuming between 1 and 9 local fish meals per year. Table 10-44 indicates that Mohawk respondents consumed statistically significantly more local fish than did control respondents during the two time periods prior to pregnancy; for the time period during pregnancy there was no significant difference in fish consumption between the two groups. Table 10-45 presents the mean number of local fish meals consumed per year by time period for all respondents and for those ever consuming (consumers only). A total of 82 (85 percent) Mohawk mothers and 72 (47 percent) control mothers reported ever consuming local fish. The mean number of local fish meals consumed per year by Mohawk respondents declined over time, from 23.4 (over one year before pregnancy) to 9.2 (less than one year before pregnancy) to 3.9 (during pregnancy); a similar decline was seen among consuming Mohawks only. There was also a decreasing trend over time in consumption among controls, though it was much less pronounced.

Table 10-46 presents the mean number of fish meals consumed per year for all participants by time period and selected characteristics (age, education, cigarette smoking, and alcohol consumption). Pairwise contrasts indicated that control participants over 34 years of age had the highest fish consumption of local fish meals (22.1) (Table 10-46). However, neither the overall nor pairwise differences by age among the Mohawk women over 34 years old were statistically significant, and may be due to the small sample size (N=6) (Fitzgerald et al., 1995). The most common fish consumed by Mohawk

mothers was yellow perch; for controls the most common fish consumed was trout.

An advantage of this study is that it presents data for fish consumption patterns for Native Americans as compared to a demographically similar group of Caucasians. Although the data are based on nursing mothers as participants, the study also captures consumption patterns prior to pregnancy (up to 1 year before and more than 1 year before). Fitzgerald et al. (1995) noted that dietary recall for a period more than one year before pregnancy may be inaccurate, but these data were the best available measure of the more distant past. They also noted that the observed decrease in fish consumption among Mohawks from the period one year before pregnancy to the period of pregnancy is due to a secular trend of declining fish consumption over time in Mohawks. This decrease, which was more pronounced than that seen in controls, may be due to health advisories promulgated by tribal, as well as state, officials. The authors note that this decreasing secular trend in Mohawks is consistent with a survey from 1979-1980 that found an overall mean of 40 fish meals per year among male and female Mohawk adults.

The data are presented as number of fish meals per year; the authors did not assign an average weight to fish meals. If assessors wanted to estimate the weight of fish consumed, some average value of weight per fish meal would have to be assumed. Pao et al. (1982) reported 104 grams as the average weight of fish consumed per eating occasion for females 19-34 years old.

10.9. OTHER FACTORS

Other factors to consider when using the available survey data include location, climate, season, and ethnicity of the angler or consumer population, as well as the parts of fish consumed and the methods of preparation. Some contaminants (for example, some dioxin compounds) have the affinity to accumulate more in certain tissues, such as the fatty tissue, as well as in certain internal organs. The effects of cooking methods for various food products on the levels of dioxin-like compounds have been addressed by evaluating a number of studies in U.S. EPA (1996b). These studies showed various results for contamination losses based on the methodology of the study and the method of food preparation. The reader is referred to U.S. EPA (1996b) for a detailed review of these studies. In addition, some studies suggest that there is a significant decrease of contaminants in cooked fish when compared with raw fish (San Diego County, 1990). Several studies cited in this section have addressed fish preparation methods and parts of fish consumed. Table 10-47 provides summary results from these studies on fish preparation methods; further details on preparation methods, as well as results from some studies on parts of fish consumed, are presented in Appendix 10B.

The moisture content (percent) and total fat content (percent) measured and/or calculated in various fish forms (i.e., raw, cooked, smoked, etc.) for selected fish species are presented in Table 10-48, based on data from USDA (1979-1984). The total percent fat content is based on the sum of saturated, monounsaturated, and polyunsaturated fat. The moisture content is based on the percent of water present.

In some cases, the residue levels of contaminants in fish are reported as the concentration of contaminant per gram of fat. These contaminants are lipophilic compounds. When using residue levels, the assessor should ensure consistency in the exposure assessment calculations by using consumption rates that are based on the amount of fat consumed for the fish species of interest. Alternately, residue levels for the "as consumed" portions of fish may be estimated by multiplying the levels based on fat by the fraction of fat (Table 10-48) per product as follows:
The resulting residue levels may then be used in conjunction with "as consumed" consumption rates.

$$\text{residue level/g product} = \left(\frac{\text{residue level}}{\text{g-fat}}\right) \times \left(\frac{\text{g-fat}}{\text{g-product}}\right) \qquad \text{(Eqn. 10-4)}$$

Additionally, intake rates may be reported in terms of units as consumed or units of dry weight. It is essential that exposure assessors be aware of this difference so that they may ensure consistency between the units used for intake rates and those used for concentration data (i.e., if the unit of food consumption is grams dry weight/day, then the unit for the amount of pollutant in the food should be grams dry weight). If necessary, as consumed intake rates may be converted to dry weight intake rates using the moisture content percentages of fish presented in Table 10-48 and the following equation:

$$IR_{dw} = IR_{ac} * [(100-W)/100] \qquad \text{(Eqn. 10-5)}$$

"Dry weight" intake rates may be converted to "as consumed" rates by using:

$$IR_{ac} = IR_{dw}/[(100\text{-}W)/100] \quad \text{(Eqn. 10-6)}$$

where:

IR_{dw} = dry weight intake rate;
IR_{ac} = as consumed intake rate; and
W = percent water content.

10.10. RECOMMENDATIONS

Fish consumption rates are recommended based on the survey results presented in the key studies described in the preceding sections. Considerable variation exists in the mean and upper percentile fish consumption rates obtained from these studies. This can be attributed largely to the characteristics of the survey population (i.e., general population, recreational anglers) and the type of water body (i.e., marine, estuarine, freshwater), but other factors such as study design, method of data collection and geographic location also play a role. Based on these study variations, recommendations for consumption rates were classified into the following categories:

- General Population;
- Recreational Marine Anglers;
- Recreational Freshwater Anglers; and
- Native American Subsistence Fishing Populations

The recommendations for each of these categories were rated according to the level of confidence the Agency has in the recommended values. These ratings were derived according to the principles outlined in Volume I, Section 1.3; the ratings and a summary of the rationale behind them are presented in tables which follow the discussion of each category.

For exposure assessment purposes, the selection of the appropriate category (or categories) from above will depend on the exposure scenario being evaluated. Assessors should use the recommended values (or range of values) unless specific studies are felt to be particularly relevant to their needs, in which case results from a specific study or studies may be used. This is particularly true for the last two categories where no nationwide key studies exist. Even where national data exist, it may be advantageous to use regional estimates if the assessment targets a particular region. In addition, seasonal, age, and gender variations should be considered when appropriate.

It should be noted that the recommended rates are based on mean (or median) values which represent a typical intake or central tendency for the population studied, and on upper estimates (i.e., 90th-99th percentiles) which represent the high-end fish consumption of the population studied. For the recreational angler populations, the recommended means and percentiles are based on all persons engaged in recreational fishing, not just those consuming recreationally caught fish.

10.10.1. Recommendations - General Population

The key study for estimating mean fish intake (reflective of both short-term and long-term consumption) is U.S. EPA (1996a) analysis of USDA CSFII 1989-1991. The recommended values for mean intake by habitat and fish type are shown in Table 10-49.

For all fish (finfish and shellfish), the recommended values are 6.6 g/day for freshwater/ estuarine fish, 13.5 g/day for marine fish, and 20.1 g/day for all fish. Note that these values are reported as uncooked fish weight. This is important because the concentration of the contaminants in fish are generally measured in the uncooked samples. Assuming that cooking results in some reductions in weight (e.g., loss of moisture), and the mass of the contaminant in the fish tissue remains constant, then the contaminant concentration in the cooked fish tissue will increase. Although actual consumption may be overestimated when intake is expressed in an uncooked basis, the net effect on the dose may be canceled out since the actual concentration may be underestimated when it is based on the uncooked sample. On the other hand, if the "as consumed" intake rate and the uncooked concentration are used in the dose equation, dose may be underestimated since the concentration in the cooked fish is likely to be higher, if the mass of the contaminant remains constant after cooking. Therefore, it is more conservative and appropriate to use uncooked fish intake rates. If concentration data can be adjusted to account for changes after cooking, then the "as consumed" intake rates are appropriate. For example, concentration may be expressed on a dry weight basis and, if data are available, loss of contaminant mass after cooking may be accounted for in the concentration. However, data on the effects of cooking in contaminant concentrations are limited and assessors generally make the conservative assumption that cooking has no effect on the contaminant mass. Both "as consumed" and uncooked fish intake values have been

presented in this handbook so that the assessor can choose the intake data that best matches the concentration data that is being used.

CSFII data were based on a short-term survey and could not be used to estimate the distribution over the long term of the average daily fish intake. The long-term average daily fish intake distribution can be estimated using the TRI study which provided dietary data for a one month period. However, because the data from the TRI study are now over 20 years old, the value presented in Table 10-49 (56 g/day) has been adjusted by upward 25 percent based on Ruffle et al. (1994) to reflect the increase in fish consumption since the TRI survey was conducted. In addition to the arguments provided by Ruffle et al. (1994) for adjusting the data upward, recent data from CSFII 1989-91 indicate an increase of fish intake of 33 percent when compared to USDA NFCS data from 1977-78. Therefore, the adjustment recommended by Ruffle et al. (1994) of 25 percent seems appropriate. Then, as suggested by Ruffle et al. (1994) the distributions generated from TRI should be shifted upward by 25 percent to estimate the current fish intake distribution. Thus, the recommended percentiles of long-term average daily fish intake are those of Javitz (1980) adjusted 25 percent upward (see Tables 10-3, 10-4). Alternatively, the log-normal distribution of Ruffle et al. (1994) (Table 10-6) may be used to approximate the long term fish intake distribution; adjusting the log mean μ by adding log(1.5)= 0.4, will shift the distribution upward by 25 percent.

It is important to note that a limitation with these data is that the total amount of fish reported by respondents included fish from all sources (e.g., fresh, frozen, canned, domestic, international origin). Neither the TRI nor the CSFII surveys identified the source of the fish consumed. This type of information may be relevant for some assessments. It should be noted that because these recommendations are based on 1989-91 CSFII data, they may not reflect the most recent changes that may have occurred in consumption patterns. However, as indicated in Section 10.2, the 1989-91 CSFII data are believed to be appropriate for assessing ingestion exposure for current populations because the rate of fish ingestion did not change dramatically between 1977-78 and 1995.

The distribution of serving sizes may be useful for acute exposure assessments. The recommended values are 129 grams for mean serving size and 326 grams for the 95th percentile serving size based on the CSFII analyses (Table 10-50).

10.10.2. Recommendations - Recreational Marine Anglers

The recommended values presented in Table 10-51 are based on the surveys of the National Marine Fisheries Service (NMFS, 1993). The intake values are based on finfish consumption only.

10.10.3. Recommendations - Recreational Freshwater Anglers

The data presented in Table 10-52 are based on mailed questionnaire surveys (Ebert et al., 1993 and West et al., 1989; 1993) and a diary study (Connelly et al., 1992; 1996). The mean intakes ranged from 5-17 g/day. The recommended mean and 95th percentile values for recreational freshwater anglers are 8 g/day and 25 g/day, respectively; these were derived by averaging the values from the three populations surveyed in the key studies. Since the two West et al. surveys studied the same population, the average of the means from the two studies was used to represent the mean for this population. The estimate from the West et al. (1989) survey was used to represent the 95th percentile for this population since the long term consumption percentiles could not be estimated from the West et al. (1993) study.

10.10.4. Recommendations - Native American Subsistence Populations

Fish consumption data for Native American subsistence populations are very limited. The CRITFC (1994) study gives a per-capita fish intake rate of 59 g/day and a 95th percentile of 170 g/day. The report by Wolfe and Walker (1987) presents harvest rates for 94 small communities engaged in subsistence harvests of natural resources. A factor of 0.5 was employed to convert the per-capita harvest rates presented in Wolfe and Walker (1987) to per capita individual consumption rates; this is the same factor used to convert from per capita household consumption rates to per capita individual consumption rates in the analysis of homegrown fish consumption from the 1987-1988 NFCS. Based on this factor, the median per-capita harvest in the 94 communities of 162 g/day (and the range of 31-1,540 g/day) is converted to the median per capita intake rate of 81 g/day (range 16-770 g/day) shown in Table 10-53. The recommended value for mean intake is 70 g/day and the recommended 95th percentile is 170 g/day.

It should be emphasized that the above recommendations refer only to Native American subsistence fishing populations, not the Native American general population. Several studies show that intake rates of recreationally caught fish among Native Americans with state fishing licenses (West et al., 1989; Ebert et al., 1993) are somewhat higher (50-100 percent) than intake rates among other anglers, but far lower than the rates shown above for Native American subsistence populations.

In addition, the studies of Peterson et al. (1994) and Fiore et al. (1989) show that total fish intake among a Native American population on a reservation (Chippewa in Wisconsin) is roughly comparable (50 percent higher) to total fish intake among licensed anglers in the same state. Also, the study of Fitzgerald et al. (1995) showed that pregnant women on a reservation (Mohawk in New York) have sport-caught fish intake rates comparable to those of a local white control population.

The survey designs, data generated, and limitations/advantages of the studies described in this report are summarized and presented in Table 10-54. The confidence in recommendations is presented in Table 10-55. The confidence rating for recreational marine anglers is presented in Table 10-56. Confidence in fish intake recommendations for recreational freshwater fish consumption is presented in Table 10-57. The confidence in intake recommendations for Native American subsistence populations is presented in Table 10-58.

10.11. REFERENCES FOR CHAPTER 10

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Table 10-1. Total Fish Consumption by Demographic Variables[a]

Demographic Category	Intake (g/person/day)	
	Mean	95th Percentile
Race		
Caucasian	14.2	41.2
Black	16.0	45.2
Oriental	21.0	67.3
Other	13.2	29.4
Sex		
Female	13.2	38.4
Male	15.6	44.8
Age (years)		
0-9	6.2	16.5
10-19	10.1	26.8
20-29	14.5	38.3
30-39	15.8	42.9
40-49	17.4	48.1
50-59	20.9	53.4
60-69	21.7	55.4
70+	13.3	39.8
Census Region		
New England	16.3	46.5
Middle Atlantic	16.2	47.8
East North Central	12.9	36.9
West North Central	12.0	35.2
South Atlantic	15.2	44.1
East South Central	13.0	38.4
West South Central	14.4	43.6
Mountain	12.1	32.1
Pacific	14.2	39.6
Community Type		
Rural, non-SMSA	13.0	38.3
Central city, 2M or more	19.0	55.6
Outside central city, 2M or more	15.9	47.3
Central city, 1M - 2M	15.4	41.7
Outside central city, 1M - 2M	14.5	41.5
Central city, 500K - 1M	14.2	41.0
Outside central city, 500K - 1M	14.0	39.7
Outside central city, 250K - 500K	12.2	32.1
Central city, 250K - 500K	14.1	40.5
Central city, 50K - 250K	13.8	43.4
Outside central city, 50K - 250K	11.3	31.7
Other urban	13.5	39.2

[a] The calculations in this table are based on respondents who consumed fish during the survey month. These respondents are estimated to represent 94 percent of the U.S. population.

Source: Javitz, 1980.

Table 10-2. Mean and 95th Percentile of Fish Consumption (g/day) by Sex and Age[a]

		Total Fish	
	Age (years)	Mean	95th Percentile
Female	0 - 9	6.1	17.3
	10 - 19	9.0	25.0
	20 - 19	13.4	34.5
	30 - 39	14.9	41.8
	40 - 49	16.7	49.6
	50 - 59	19.5	50.1
	60 - 69	19.0	46.3
	70+	10.7	31.7
Male	0 - 9	6.3	15.8
	10 - 19	11.2	29.1
	20 - 19	16.1	43.7
	30 - 39	17.0	45.6
	40 - 49	18.2	47.7
	50 - 59	22.8	57.5
	60 - 69	24.4	61.1
	70+	15.8	45.7
Overall		14.3	41.7

[a] The calculations in this table are based upon respondents who consumed fish in the month of the survey. These respondents are estimated to represent 94.0% of the U.S. population.

Source: Javitz, 1980.

Table 10-3. Percent Distribution of Total Fish Consumption for Females by Age[a]

	Consumption Category (g/day)										
	0.0-5.0	5.1-10.0	10.1-15.0	15.1-20.0	20.1-25.0	25.1-30.0	30.1-37.5	37.6-47.5	47.6-60.0	60.1-122.5	over 122.5
Age (yrs)	Percentage										
0-9	55.5	26.8	11.0	3.7	1.0	1.1	0.7	0.3	0.0	0.0	0.0
10-19	17.8	31.4	15.4	6.9	3.5	2.4	1.2	0.7	0.2	0.4	0.0
20-29	28.1	26.1	20.4	11.8	6.7	3.5	4.4	2.2	0.9	0.9	0.0
30-39	22.4	23.6	18.0	12.7	8.3	4.8	3.8	2.8	1.9	1.7	0.1
40-49	17.5	21.9	20.7	13.2	9.3	4.5	4.6	2.8	3.4	2.1	0.2
50-59	17.0	17.4	16.8	15.5	10.5	8.5	6.8	5.2	4.2	2.0	0.2
60-69	11.5	16.9	20.6	15.9	9.1	9.2	6.0	6.1	2.4	2.1	0.2
70+	41.9	22.1	12.3	9.7	5.2	2.9	2.6	1.2	0.8	1.2	0.1
Overall	28.9	24.0	16.8	10.7	6.4	4.3	3.5	2.4	1.6	1.2	0.1

[a] The percentage of females in an age bracket whose average daily fish consumption is within the specified range.
The calculations in this table are based upon the respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% of the U.S. population.
Source: Javitz, 1980.

Table 10-4. Percent Distribution of Total Fish Consumption for Males by Age[a]

	Consumption Category (g/day)										
	0.0-5.0	5.1-10.0	10.1-15.0	15.1-20.0	20.1-25.0	25.1-30.0	30.1-37.5	37.6-47.5	47.6-60.0	60.1-122.5	over 122.5
Age (yrs)	Percentage										
0-9	52.1	30.1	11.9	3.1	1.2	0.6	0.7	0.1	0.2	0.1	0.0
10-19	27.8	29.3	19.0	10.4	6.0	3.2	1.7	1.7	0.4	0.5	0.0
20-29	16.7	22.9	19.6	14.5	8.8	6.2	4.4	3.1	1.9	1.9	0.1
30-39	16.6	21.2	19.2	13.2	9.5	7.3	5.2	3.2	1.3	2.2	0.0
40-49	11.9	22.3	18.6	14.7	8.4	8.5	5.3	5.2	3.3	1.7	0.1
50-59	9.9	15.2	15.4	14.4	10.4	9.7	8.7	7.6	4.3	4.1	0.2
60-69	7.4	15.0	15.6	12.8	11.4	8.5	9.9	8.3	5.5	5.5	0.1
70+	24.5	21.7	15.7	9.9	9.8	5.3	5.4	3.1	1.7	2.8	0.1
Overall	22.6	23.1	17.0	11.3	7.7	5.7	4.6	3.6	2.2	2.1	0.1

[a] The percentage of males in an age bracket whose average daily fish consumption is within the specified range.
The calculations in this table are based upon respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% of the U.S. population.
Source: Javitz, 1980.

Table 10-5. Mean Total Fish Consumption by Species[a]

Species	Mean consumption (g/day)	Species	Mean consumption (g/day)
Not reported	1.173	Mullet[b]	0.029
Abalone	0.014	Oysters[b]	0.291
Anchovies	0.010	Perch (Freshwater)[b]	0.062
Bass[b]	0.258	Perch (Marine)	0.773
Bluefish	0.070	Pike (Marine)[b]	0.154
Bluegills[b]	0.089	Pollock	0.266
Bonito[b]	0.035	Pompano	0.004
Buffalofish	0.022	Rockfish	0.027
Butterfish	0.010	Sablefish	0.002
Carp[b]	0.016	Salmon[b]	0.533
Catfish (Freshwater)[b]	0.292	Scallops[b]	0.127
Catfish (Marine)[b]	0.014	Scup[b]	0.014
Clams[b]	0.442	Sharks	0.001
Cod	0.407	Shrimp[b]	1.464
Crab, King	0.030	Smelt[b]	0.057
Crab, other than King[b]	0.254	Snapper	0.146
Crappie[b]	0.076	Snook[b]	0.005
Croaker[b]	0.028	Spot[b]	0.046
Dolphin[b]	0.012	Squid and Octopi	0.016
Drums	0.019	Sunfish	0.020
Flounders[b]	1.179	Swordfish	0.012
Groupers	0.026	Tilefish	0.003
Haddock	0.399	Trout (Freshwater)[b]	0.294
Hake	0.117	Trout (Marine)[b]	0.070
Halibut[b]	0.170	Tuna, light	3.491
Herring	0.224	Tuna, White Albacore	0.008
Kingfish	0.009	Whitefish[b]	0.141
Lobster (Northern)[b]	0.162	Other finfish[b]	0.403
Lobster (Spiny)	0.074	Other shellfish[b]	0.013
Mackerel, Jack	0.002		
Mackerel, other than Jack	0.172		

[a] The calculations in this table are based upon respondents who consumed fish during the month of the survey. These respondents are estimated to represent 94% percent of the U.S. population.

[b] Designated as freshwater or estuarine species by Stephan (1980).

Source: Javitz, 1980.

Table 10-6. Best Fits of Lognormal Distributions Using the NonLinear Optimization (NLO) Method

	Adults	Teenagers	Children
Shellfish			
μ	1.370	-0.183	0.854
σ	0.858	1.092	0.730
(min SS)	27.57	1.19	16.06
Finfish (freshwater)			
μ	0.334	0.578	-0.559
σ	1.183	0.822	1.141
(min SS)	6.45	23.51	2.19
Finfish (saltwater)			
μ	2.311	1.691	0.881
σ	0.72	0.830	0.970
(min SS)	30.13	0.33	4.31

The following equations may be used with the appropriate μ and σ values to obtain an average Daily Consumption Rate (DCR), in grams, and percentiles of the DCR distribution.

$DCR50 = \exp(\mu)$

$DCR90 = \exp[\mu + z(0.90) \cdot \sigma]$

$DCR99 = \exp[\mu + z(0.99) \cdot \sigma]$

$DCR_{avg} = \exp[\mu + 0.5 \cdot \sigma^2]$

Source: Ruffle et al., 1994.

Table 10-7. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population (Uncooked Fish Weight)

Habitat	Statistic	Estimate (90% Interval)		
		Finfish	Shellfish	Total
Fresh/Estuarine	Mean	3.6 (3.0 - 4.1)	2.4 (2.0 - 2.8)	6.0 (5.3 - 6.7)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	0.4 (0.00 - 0.7)	0.0 (0.0 - 0.3)	15.9 (14.4 - 17.8)
	95th%	21.7 (14.8 - 25.8)	13.3 (11.7 - 17.8)	40.0 (37.9 - 44.8)
	99th%	87.3 (80.1 - 98.0)	63.6 (60.4 - 68.5)	107.6 (98.3 - 109.1)
Marine	Mean	12.5 (11.5 - 13.5)	1.6 (1.3 - 1.9)	14.1 (13.1 - 15.1)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	47.5 (43.6 - 49.8)	0.0 (0.0 - 0.0)	52.1 (47.8 - 55.9)
	95th%	74.6 (70.3 - 76.3)	0.0 (0.0 - 6.8)	76.5 (74.6 - 80.9)
	99th%	133.0 (127.8 - 143.2)	50.3 (44.5 - 59.0)	138.2 (133.0 - 155.1)
All Fish	Mean	16.1 (15.0 - 17.2)	4.0 (3.4 - 4.6)	20.1 (18.8 - 21.4)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	59.1 (54.6 - 62.3)	0.0 (0.0 - 3.5)	70.1 (65.4 - 74.2)
	95th%	84.4 (81.3 - 89.6)	22.7 (21.8 - 26.6)	102.0 (99.3 - 106.7)
	99th%	156.7 (148.7 - 168.1)	99.0 (87.8 - 109.6)	173.2 (162.8 - 176.5)

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications; percent consuming gives the percentage of individuals consuming the specified category of fish during the 3-day survey period. Estimates are projected from a sample of 11,912 individuals to the U.S. population.

Source: U.S. EPA, 1996a.

Table 10-8. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) by Habitat for Consumers Only (Uncooked Fish Weight)

Habitat	Statistic	Estimate	90% Interval
Fresh/Estuarine[a]	Mean	86.2	78.4 - 94.0
	50th%	48.8	45.6 - 54.9
	90th%	217.9	205.3 - 237.3
	95th%	290.0	267.1 - 325.6
	99th%	489.3	424.9 - 534.2
	Percent Consuming	18.5	
Marine[b]	Mean	113.1	107.8 - 118.4
	50th%	93.3	92.0 - 94.9
	90th%	222.7	216.5 - 225.6
	95th%	271.7	260.6 - 279.9
	99th%	415.9	367.3 - 440.5
	Percent Consuming	30.1	
All Fish[c]	Mean	129.0	123.7 - 134.3
	50th%	101.9	98.9 - 103.9
	90th%	249.1	241.0 - 264.1
	95th%	326.0	306.1 - 335.6
	99th%	497.5	469.2 - 519.7
	Percent Consuming	36.9	

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications; percent consuming gives the percentage of individuals consuming the specified category of fish during the 3-day survey period.

a Sample size = 1,892; population size = 44,946,000
b Sample size = 3,184; population size = 73,100,000
c Sample size = 3,927; population size = 89,800,000

Source: U.S. EPA, 1996a.

Table 10-9. Per Capita Distribution of Fish Intake (mg/kg-day) by Habitat and Fish Type for U.S. Population (Uncooked Fish Weight)

		Estimate (90% Interval)		
Habitat	Statistic	Finfish	Shellfish	Total
Fresh/Estuarine	Mean	58.1 (48.4 - 67.7)	35.9 (30.2 - 41.6)	94.0 (83.4 - 104.6)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	5.9 (0.0 - 12.3)	0.0 (0.0 - 3.8)	251.8 (222.5 - 282.6)
	95th%	340.5 (252.9 - 410.1)	190.0 (155.7 - 268.3)	677.7 (631.9 - 729.1)
	99th%	1,401.9 (1,283.9 - 1,511.8)	953.5 (871.3 - 1,007.4)	1,593.3 (1,511.8 - 1,659.2)
Marine	Mean	215.8 (195.9 - 235.6)	24.3 (20.6 - 28.0)	240.1 (220.1 - 260.0)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	783.4 (752.5 - 842.2)	0.0 (0.0 - 0.0)	855.6 (809.7 - 909.8)
	95th%	1,208.1 (1,149.5 - 1,264.9)	0.0 (0.0 - 88.8	1,271.5 (1,227.2 - 1,371.2)
	99th%	2,400.0 (2,284.2 - 2,660.1)	701.3 (636.2 - 944.7)	2,575.3 (2,393.2 - 2,708.6)
All Fish	Mean	273.9 (252.0 - 295.7)	60.2 (52.3 - 68.2)	334.1 (311.3 - 356.9)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	966.1 (893.3 - 1,039.5)	0.0 (0.0 - 47.4)	1,123.1 (1,090.8 - 1,179.0)
	95th%	1,434.3 (1,371.2 - 1,526.8)	372.5 (324.1 - 460.5)	1,684.2 (1,620.5 - 1,718.5)
	99th%	2,857.5 (2,649.6 - 3,003.6)	1,412.4 (1,296.0 - 1,552.1)	3,092.8 (2,973.7 - 3,250.2)

Note: Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications. Estimates are projected from a sample of 11,912 individuals to the U.S. population.

Source: U.S. EPA, 1996a.

Table 10-10. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) by Habitat for Consumers Only (Uncooked Fish Weight)

Habitat	Statistic	Estimate	90% Interval
Fresh/Estuarine[a]	Mean	1,363.4	1,242.2 - 1,484.7
	50th%	819.7	736.9 - 895.7
	90th%	3,325.1	3,232.6 - 3,677.0
	95th%	4,408.2	4,085.6 - 4,781.3
	99th%	7,957.5	6,979.2 - 8,921.0
	Percent Consuming	18.5	
Marine[b]	Mean	1,927.0	1,829.5 - 2,024.4
	50th%	1,507.7	1,470.7 - 1,538.8
	90th%	3,752.9	3,632.0 - 4,001.2
	95th%	5,018.7	4,852.1 - 5,267.3
	99th%	8,448.3	7,215.7 - 9,136.9
	Percent Consuming	30.1	
All Fish[c]	Mean	2,145.3	2,055.9 - 2,234.6
	50th%	1,662.8	1,610.7 - 1,720.1
	90th%	4,223.9	4,085.8 - 4,454.2
	95th%	5,477.9	5,163.3 - 5,686.0
	99th%	9,171.5	8,605.4 - 9,796.6
	Percent Consuming	36.9	

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications; percent consuming gives the percentage of individuals consuming the specified category of fish during the 3-day survey period.

a Sample size = 1,892; population size = 44,946,000
b Sample size = 3,184; population size = 73,100,000
c Sample size = 3,927; population size = 89,800,000

Source: U.S. EPA, 1996a.

Table 10-11. Per Capita Distribution of Fish Intake (g/day) by Habitat and Fish Type for the U.S. Population (Cooked Fish Weight - As Consumed)

Habitat	Statistic	Estimate (90% Interval)		
		Finfish	Shellfish	Total
Fresh/Estuarine	Mean	2.8 (2.4 - 3.3)	1.9 (1.6 - 2.2)	4.7 (4.2 - 5.3)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	0.3 (0.0 - 0.7)	0.0 (0.0 - 0.2)	12.6 (10.9 - 14.0)
	95th%	17.2 (12.9 - 20.8)	10.1 (7.9 - 13.8)	32.2 (29.8 - 35.2)
	99th%	70.9 (60.3 - 75.7)	49.9 (45.6 - 56.4)	82.5 (77.2 - 86.4)
Marine	Mean	9.7 (9.0 - 10.5)	1.2 (1.0 - 1.4)	10.9 (10.1 - 11.7)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)
	90th%	37.3 (33.7 - 37.4)	0.0 (0.0 - 0.0)	39.5 (37.3 - 42.9)
	95th%	56.2 (55.6 - 58.2)	0.0 (0.0 - 5.3)	59.6 (57.0 - 61.8)
	99th%	103.1 (98.5 - 112.0)	37.0 (35.4 - 44.5)	106.8 (104.6 - 114.6)
All Fish	Mean	12.6 (11.7 - 13.4)	3.1 (2.7 - 3.5)	15.7 (14.7 - 16.6)
	50th%	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.-0)
	90th%	46.0 (43.6 - 49.0)	0.0 (0.0 - 2.6)	55.0 (51.4 - 56.0)
	95th%	67.0 (63.0 - 70.7)	18.9 (16.7 - 22.1)	78.3 (75.2 - 80.6)
	99th%	119.1 (113.9 - 125.9)	74.3 (68.7 - 82.0)	133.5 (125.3 - 140.2)

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications. Estimates are projected from a sample of 11,912 individuals to the U.S. population.

Source: U.S. EPA, 1996a.

Table 10-12. Per Capita Distribution of Fish Intake (g/day) by Habitat for Consumers Only
(Cooked Fish Weight - As Consumed)

Habitat	Statistic	Estimate	90% Interval
Fresh/Estuarine[a]	Mean	68.0	61.9 - 74.1
	50th%	39.5	36.2 - 44.7
	90th%	170.8	158.7 - 181.8
	95th%	224.8	212.9 - 246.0
	99th%	374.7	336.5 - 341.3
	Percent Consuming	18.5	
Marine[b]	Mean	87.8	83.7 - 91.8
	50th%	71.8	69.7 - 74.2
	90th%	169.4	167.0 - 173.7
	95th%	208.5	198.1 - 221.7
	99th%	320.4	292.8 - 341.9
	Percent Consuming	30.1	
All Fish[c]	Mean	100.6	96.7 - 104.6
	50th%	80.8	79.3 - 83.9
	90th%	197.4	188.7 - 205.1
	95th%	253.4	231.5 - 264.5
	99th%	371.6	359.3 - 401.6
	Percent Consuming	36.9	

Note: Percentile confidence intervals estimated using the bootstrap method with 1,000 replications; percent consuming gives the percentage of individuals consuming the specified category of fish during the 3-day survey period.

a Sample size = 1,892; population size = 44,946,000
b Sample size = 3,184; population size = 73,100,000
c Sample size = 3,927; population size = 89,800,000

Source: U.S. EPA, 1996a.

Table 10-13. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - As Consumed (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	1.58 (1.06-2.10)	1.44 (0.00-4.07)	12.51 (6.00-14.20)	36.09 (28.53-43.20)
15 - 44	2891	4.28 (3.55-5.02)	10.90 (8.79-13.84)	28.80 (26.26-33.53)	70.87 (64.74-90.56)
45 or older	2340	5.27 (4.21-6.32)	18.72 (15.19-22.12)	34.67 (29.17-39.38)	85.35 (71.71-100.50)
All ages	6662	4.02 (3.43-4.61)	10.66 (8.11-13.19)	28.11 (23.14-31.27)	71.98 (60.38-86.40)
Males					
14 or under	1546	2.17 (1.32-3.02)	0.99 (0.21-6.67)	14.94 (11.88-22.33)	48.72 (37.48-52.29)
15 - 44	2151	6.14 (5.08-7.19)	18.19 (10.21-24.20)	48.61 (35.42-54.65)	96.32 (85.60-115.75)
45 or older	1553	7.12 (5.87-8.38)	22.67 (19.28-27.83)	46.62 (41.27-58.01)	103.07 (86.41-125.11)
All ages	5250	5.46 (4.81-6.11)	16.05 (12.41-19.30)	40.29 (35.92-43.73)	86.40 (78.37-103.07)
Both Sexes					
14 or under	2977	1.88 (1.36-2.40)	1.31 (0.00-4.33)	13.90 (9.32-15.05)	40.77 (35.15-44.82)
15 - 44	5042	5.17 (4.46-5.87)	13.88 (12.05-17.21)	36.21 (28.64-47.31)	86.14 (74.67-96.67)
45 or older	3893	6.11 (5.20-7.02)	21.48 (16.69-23.33)	40.55 (35.80-47.31)	88.18 (85.33-103.07)
All ages	11912	4.71 (4.17-5.25)	12.62 (10.91-13.98)	32.16 (29.81-35.15)	82.45 (77.17-86.40)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-14. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - As Consumed (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	6.60 (5.16-8.05)	24.84 (18.67-31.20)	37.32 (32.27-42.05)	87.05 (63.26-112.06)
15 - 44	2891	9.97 (8.94-11.01)	36.83 (31.42-41.99)	55.53 (47.67-59.59)	105.32 (96.98-112.00)
45 or older	2340	12.59 (11.36-13.82)	42.92 (38.92-47.66)	63.85 (57.27-72.36)	103.08 (91.61-121.52)
All ages	6662	10.10 (9.27-10.93)	36.97 (34.86-37.33)	55.54 (51.67-56.98)	102.01 (97.67-110.69)
Males					
14 or under	1546	7.25 (5.72-8.79)	24.85 (19.92-33.85)	49.89 (42.09-56.45)	92.64 (65.87-132.39)
15 - 44	2151	13.33 (11.89-14.77)	52.73 (48.34-55.80)	71.49 (63.99-80.00)	116.51 (106.06-143.31)
45 or older	1553	13.32 (11.73-14.92)	50.39 (47.13-53.33)	64.51 (61.64-74.58)	116.86 (106.93-144.94)
All ages	5250	11.85 (10.75-12.95)	47.13 (44.52-49.80)	64.50 (62.46-67.53)	113.94 (103.47-130.00)
Both Sexes					
14 or under	2977	6.93 (5.63-8.23)	24.88 (22.64-28.08)	42.07 (38.15-48.96)	91.64 (68.59-112.06)
15 - 44	5042	11.58 (10.55-12.60)	44.24 (39.84-46.70)	62.18 (57.88-69.72)	110.07 (103.50-120.49)
45 or older	3893	12.92 (11.86-13.98)	46.51 (38.98-50.97)	64.19 (60.67-72.00)	113.33 (104.59-119.53)
All ages	11912	10.94 (10.14-11.73)	39.51 (37.29-42.91)	59.62 (57.03-61.84)	106.84 (104.59-114.55)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-15. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - As Consumed (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	8.19 (6.53-9.84)	32.28 (26.78-37.33)	43.09 (37.99-51.55)	95.19 (63.26-113.96)
15 - 44	2891	14.25 (12.96-15.55)	47.13 (41.95-55.83)	71.58 (64.74-82.11)	120.84 (110.69-132.79)
45 or older	2340	17.86 (16.19-19.52)	56.70 (54.13-62.99)	81.94 (74.63-88.23)	130.51 (122.02-140.21)
All ages	6662	14.13 (13.07-15.18)	46.44 (43.63-49.67)	70.23 (67.27-73.91)	120.22 (112.06-126.07)
Males					
14 or under	1546	9.42 (7.60-11.25)	34.85 (27.77-42.09)	52.85 (49.93-62.50)	98.36 (71.74-132.39)
15 - 44	2151	19.46 (17.75-21.18)	68.60 (65.74-74.70)	93.65 (85.60-96.96)	149.07 (142.73-154.41)
45 or older	1553	20.45 (18.41-22.49)	64.44 (61.33-69.27)	87.21 (85.33-100.19)	168.49 (143.78-174.55)
All ages	5250	17.31 (16.04-18.59)	60.23 (56.91-62.99)	85.69 (80.61-93.32)	143.91 (135.35-154.15)
Both Sexes					
14 or under	2977	8.82 (7.39-10.24)	32.88 (27.97-37.11)	50.95 (44.64-53.86)	98.33 (86.40-113.96)
15 - 44	5042	16.74 (15.54-17.94)	57.88 (56.00-60.85)	84.59 (79.91-90.83)	138.21 (122.84-149.15)
45 or older	3893	19.03 (17.54-20.52)	61.32 (56.00-65.74)	86.21 (77.42-94.70)	143.91 (131.12-171.37)
All ages	11912	15.65 (14.67-16.63)	55.02 (51.38-56.00)	78.34 (75.21-80.56)	133.46 (125.27-140.21)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-16. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population Aged 18 Years and Older by Habitat - As Consumed

		Grams/day		
			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	5.59	4.91	6.28
	50th %	0.00	0.00	0.00
	90th %	17.80	14.89	20.63
	95th %	39.04	36.13	42.16
	99th %	86.30	81.99	96.67
Marine	Mean	12.42	11.55	13.29
	50th %	0.00	0.00	0.00
	90th %	45.98	44.48	48.34
	95th %	64.08	61.61	68.05
	99th %	111.38	101.94	120.49
All Fish	Mean	18.01	16.85	19.17
	50th %	0.00	0.00	0.00
	90th %	60.64	57.06	64.63
	95th %	86.25	80.29	91.00
	99th %	142.96	134.23	154.15

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Estimates are projected from a sample of 8,478 individuals of age 18 and older to the U.S. population of 177,807,000 individuals of age 18 and older using 3-year combined survey weights.
Source: U.S. EPA, 1996a.

Table 10-17. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - As Consumed (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	67.12 (46.16-88.09)	57.30 (0.00-128.52)	460.16 (218.56-559.86)	1356.54 (1295.24-2118.93)
15 - 44	2891	66.22 (55.35-77.08)	174.96 (115.11-205.05)	451.04 (421.65-505.49)	1188.16 (977.85-1278.63)
45 or older	2340	78.29 (63.27-93.30)	273.63 (209.63-300.11)	548.66 (466.18-633.87)	1251.00 (1038.97-1324.90)
All ages	6662	70.32 (60.09-80.55)	177.91 (132.69-212.30)	497.30 (442.20-558.85)	1269.76 (1093.19-1328.24)
Males					
14 or under	1546	73.93 (44.89-102.96)	28.10 (8.86-231.33)	723.93 (423.52-785.58)	1290.10 (1279.82-1355.11)
15 - 44	2151	75.35 (62.00-88.70)	230.13 (132.30-309.85)	577.84 (410.09-706.31)	1132.23 (1028.61-1416.47)
45 or older	1553	86.75 (70.91-102.58)	291.50 (230.15-364.24)	584.96 (512.66-630.77)	1231.60 (1115.58-1566.68)
All ages	5250	78.36 (69.10-87.61)	231.57 (186.27-276.04)	589.22 (549.64-630.09)	1265.10 (1133.18-1355.11)
Both Sexes					
14 or under	2977	70.59 (53.29-87.89)	53.24 (0.00-118.48)	556.34 (417.11-683.80)	1347.67 (1279.82-1390.82)
15 - 44	5042	70.58 (61.27-79.89)	197.11 (154.78-229.29)	502.26 (410.09-604.29)	1167.57 (1021.96-1279.82)
45 or older	3893	82.12 (70.19-94.05)	286.93 (228.49-332.88)	566.30 (505.10-625.21)	1251.55 (1115.58-1324.90)
All ages	11912	74.16 (65.74-82.57)	204.00 (177.97-225.16)	547.64 (505.10-565.37)	1274.55 (1197.29-1324.90)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-18. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - As Consumed (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	256.90 (207.04-306.76)	936.94 (723.73-1055.43)	1545.15 (1260.24-1760.26)	3060.22 (2403.50-4354.46)
15 - 44	2891	159.79 (142.76-176.82)	573.49 (493.39-663.16)	873.73 (780.56-929.55)	1700.21 (1578.65-1815.48)
45 or older	2340	191.08 (171.33-210.83)	644.33 (608.39-725.83)	978.84 (881.06-1103.01)	1694.58 (1488.32-1791.84)
All ages	6662	190.61 (172.89-208.33)	658.64 (627.61-700.33)	1024.76 (958.94-1096.14)	1979.45 (1793.40-2137.78)
Males					
14 or under	1546	230.25 (188.33-272.17)	846.57 (734.83-987.18)	1504.37 (1320.60-1749.26)	2885.08 (2631.87-3430.60)
15 - 44	2151	165.92 (147.73-184.12)	626.85 (593.90-680.90)	933.05 (833.43-982.30)	1472.98 (1411.97-1525.47)
45 or older	1553	164.37 (144.87-183.87)	621.00 (562.90-691.03)	839.06 (800.23-946.97)	1422.94 (1293.89-1791.31)
All ages	5250	181.08 (163.00-199.15)	670.19 (622.62-714.53)	981.87 (934.45-1071.54)	1923.63 (1802.17-1972.86)
Both Sexes					
14 or under	2977	243.31 (202.43-284.18)	873.87 (741.53-1093.69)	1522.52 (1371.10-1587.20)	3059.93 (2732.63-3430.60)
15 - 44	5042	162.72 (148.13-177.31)	602.58 (564.88-648.54)	893.82 (856.58-940.85)	1576.09 (1503.11-1697.71)
45 or older	3893	178.99 (164.13-193.84)	628.06 (555.84-700.65)	914.67 (825.21-1040.75)	1568.85 (1483.71-1760.74)
All ages	11912	186.06 (170.81-201.31)	663.00 (627.39-717.18)	991.96 (960.40-1044.69)	1942.17 (1815.48-2042.99)

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-19. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - As Consumed (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	324.02 (264.25-383.80)	1091.52 (929.29-1407.54)	1690.99 (1513.97-2072.35)	3982.60 (3219.32-4568.45)
15 - 44	2891	226.01 (205.01-247.01)	755.51 (641.02-879.29)	1126.02 (975.49-1269.56)	2195.86 (1762.90-2310.54)
45 or older	2340	269.37 (243.36-295.38)	862.18 (796.63-955.82)	1296.64 (1186.00-1344.85)	2147.32 (1791.84-2354.25)
All ages	6662	260.93 (239.15-282.72)	873.61 (796.63-911.89)	1323.29 (1269.56-1418.85)	2361.12 (2272.41-2598.14)
Males					
14 or under	1546	304.17 (251.91-356.43)	1172.17	1575.43 (1496.19-1943.82)	3393.84 (2731.95-3733.22)
15 - 44	2151	241.27 (219.25-263.29)	(1085.62-1320.60)	1208.43 (1101.68-1266.32)	1760.48 (1611.45-1851.26)
45 or older	1553	251.12 (225.48-276.76)	867.70 (814.06-919.25)	1122.80 (1041.28-1266.18)	1922.33 (1786.53-2275.93)
All ages	5250	259.43 (239.81-279.06)	797.83 (762.30-858.52)	1298.95 (1224.82-1366.86)	2346.64 (1972.86-2631.87)
			894.96 (842.29-938.16)		
Both Sexes					
14 or under	2977	313.90 (268.42-359.38)	1128.26	1679.91 (1546.20-1848.43)	3419.49 (3184.04-3733.22)
15 - 44	5042	233.30 (216.16-250.44)	(1005.58-1320.60)	1155.30 (1102.57-1212.19)	2003.46 (1787.65-2182.19)
45 or older	3893	261.10 (240.34-281.87)	828.12 (771.73-868.89)	1249.97 (1101.32-1323.53)	1967.01 (1796.52-2257.50)
All ages	11912	260.22 (242.60-277.83)	818.10 (771.23-882.53)	1308.54 (1267.15-1346.71)	2356.54 (2224.54-2556.68)
			880.47 (844.35-918.79)		

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-20. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population Aged 18 Years and Older by Habitat - As Consumed

			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	75.56	66.37	84.75
	50th %	0.00	0.00	0.00
	90th %	242.49	205.05	277.26
	95th %	547.61	493.47	587.37
	99th %	1,171.84	1,123.52	1,252.78
Marine	Mean	172.86	160.73	184.99
	50th %	0.00	0.00	0.00
	90th %	624.83	598.84	670.34
	95th %	911.05	877.29	952.66
	99th %	1,573.20	1,468.43	1,713.17
All Fish	Mean	248.42	232.19	264.64
	50th %	0.00	0.00	0.00
	90th %	829.02	791.06	872.61
	95th %	1,197.36	1,133.18	1,264.74
	99th %	2,014.67	1,839.55	2,180.87

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Estimates are projected from a sample of 8,478 individuals of age 18 and older to the population of 177,807,000 individuals of age 18 and older using 3-year combined survey weights.
Source: U.S. EPA, 1996a.

Table 10-21. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - As Consumed (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	138	38.44	91.30	128.97	182.66
15 - 44	445	61.40	148.83	185.44	363.56
45 or older	453	62.49	150.67	214.91	296.69
All ages	1036	58.82 (51.57-66.06)	145.65 (130.73-152.24)	190.28 (173.88-219.03)	330.41 (259.20-526.69)
Males					
14 or under	157	52.44	112.05	154.44	230.74
15 - 44	356	81.56	224.01	275.02	371.53
45 or older	343	82.23	192.31	255.68	449.09
All ages	856	77.50 (70.21-84.80)	197.93 (169.51-224.85)	253.48 (216.54-290.00)	404.65 (371.63-421.60)
Both Sexes					
14 or under	295	45.73	108.36	136.24	214.62
15 - 44	801	71.44	180.67	230.95	371.52
45 or older	796	71.81	174.54	231.38	427.73
All ages	1892	68.00 (61.92-74.07)	170.84 (158.74-181.79)	224.78 (212.91-245.98)	374.74 (336.50-431.34)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Acute Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-22. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - As Consumed (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	315	69.04	114.23	162.37	336.59
15 - 44	774	76.53	149.78	178.74	271.06
45 or older	715	85.24	167.11	218.35	264.8
All ages	1804	78.47 (74.43-82.51)	155.38 (147.00-166.64)	195.15 (179.12-212.07)	279.79 (263.48-336.17)
Males					
14 or under	348	78.44	160.97	190.68	336.98
15 - 44	565	104.57	191.29	227.56	316.69
45 or older	467	101.46	188.77	259.85	333.18
All ages	1380	98.59 (93.16-104.03)	184.53 (173.46-194.13)	224.89 (210.00-250.28)	328.18 (310.42-348.49)
Both Sexes					
14 or under	663	73.62	153.2	176.9	337.24
15 - 44	1339	89.93	171.88	209.17	308.06
45 or older	1182	92.19	178.33	223.82	314.44
All ages	3184	87.77 (83.74-91.80)	169.39 (167.00-173.65)	209.50 (198.11-221.73)	320.41 (292.80-341.88)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Acute Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-23. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - As Consumed (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	378	69.54	126.22	165.27	338.04
15 - 44	952	88.8	170.01	212.56	361.04
45 or older	879	96.47	184.42	226.25	310.12
All ages	2209	88.47 (83.98-92.97)	170.10 (166.63-173.88)	220.56 (201.97-236.00)	340.71 (289.17-368.51)
Males					
14 or under	429	79.72	161.62	190	308.59
15 - 44	702	124.78	230.77	296.66	397.7
45 or older	587	119.44	224.82	262.43	434.28
All ages	1718	114.18 (108.79-119.56)	219.96 (209.17-229.91)	272.49 (254.99-301.51)	411.68 (371.43-447.85)
Both Sexes					
14 or under	807	74.8	153.7	178.08	337.46
15 - 44	1654	106.06	203.33	271.66	372.77
45 or older	1466	106.62	209.34	254.69	407.14
All ages	3927	100.63 (96.66-104.60)	197.44 (188.74-205.12)	253.38 (231.51-264.45)	371.59 (359.29-401.61)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Acute Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-24. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only Aged 18 Years and Older by Habitat - As Consumed

			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	70.91	64.16	77.65
n = 1,541	50th %	42.45	37.24	46.91
N = 37,166,000	90th %	176.58	165.08	193.26
	95th %	230.41	224.00	255.55
	99th %	402.56	358.58	518.41
Marine	Mean	91.49	87.35	95.64
n = 2,432	50th %	77.56	74.89	78.52
N = 57,830,000	90th %	172.29	168.00	182.00
	95th %	215.62	201.99	225.63
	99th %	313.05	292.80	324.81
All Fish	Mean	106.39	102.37	110.41
n = 3,007	50th %	85.36	84.00	87.36
N = 70,949,000	90th %	206.76	197.84	213.00
	95th %	258.22	241.00	266.86
	99th %	399.26	336.50	423.56

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Consumers only are individuals who consumed fish at least once during the 3-day reporting period; n = sample size; N = population size. Estimates are projected from a sample of consumers only 18 years of age and older to the population of consumers only 18 years of age and older using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conterminous states.
Source: U.S. EPA, 1996a.

Table 10-25. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only by Age and Gender - As Consumed (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females	0	0	0	0	0
14 or under	138	1639.20	3915.56	6271.09	10113.24
15 - 44	445	961.58	2578.81	3403.75	6167.24
45 or older	453	927.85	2229.97	2894.18	4338.36
All ages	1036	1037.29 (905.50-1169.09)	2582.5 (2248.8-2734.5)	3434.16 (2927.72-3979.82)	6923.5 (4757.8-9134.9)
Males	0	0	0	0	0
14 or under	157	1798.24	3759.29	3952.99	7907.38
15 - 44	356	1004.96	2744.61	3348.86	4569.62
45 or older	343	992.11	2448.54	3281.38	5716.41
All ages	856	1117.74 (1011.55-1223.94)	2789.95 (2526.87-3132.65)	3399.26 (3256.87-3907.77)	5259.97 (4834.34-6593.97)
Both Sexes	0	0	0	0	0
14 or under	295	1721.99	3760.67	4208.18	9789.49
15 - 44	801	983.19	2616.63	3360.85	5089.78
45 or older	796	958.20	2394.21	3121.09	5157.95
All ages	1892	1076.80 (980.00-1173.61)	2695.81 (2546.77-2819.33)	3399.46 (3132.65-3839.47)	6526.10 (5270.61-6931.61)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-26. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only by Age and Gender - As Consumed (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	315	2591.57	5074.80	6504.67	9970.44
15 - 44	774	1227.41	2469.67	3007.98	4800.68
45 or older	715	1293.99	2642.60	3565.34	4237.73
All ages	1804	1486.90 (1400.58-1573.23)	2992.38 (2841.13-3303.96)	3961.24 (3768.48-4192.13)	6521.73 (5792.54-7794.41)
Males					
14 or under	348	2471.15	4852.33	5860.72	8495.57
15 - 44	565	1302.62	2390.20	2882.91	3887.23
45 or older	467	1242.49	2251.43	2877.73	4016.80
All ages	1380	1505.19 (1411.84-1598.55)	2899.23 (2797.30-3199.05)	3836.02 (3563.32-4581.61)	5859.85 (5247.79-7895.62)
Both Sexes					
14 or under	663	2532.95	5068.69	6376.47	8749.02
15 - 44	1339	1263.35	2464.80	2961.92	4251.47
45 or older	1182	1271.92	2461.37	3383.46	4220.78
All ages	3184	1495.37 (1422.63-1568.12)	2956.38 (2838.46-3083.70)	3887.52 (3770.65-4113.22)	6510.73 (5772.57-6852.01)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-27. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumer Only by Age and Gender - As Consumed (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	378	2683.51	5299.68	7160.73	12473.65
15 - 44	952	1414.54	2726.46	3740.83	6703.25
45 or older	879	1449.43	2838.76	3736.61	4693.94
All ages	2209	1637.08 (1546.08-1728.08)	3122.82 (2992.63-3308.93)	4312.16 (3969.22-4710.75)	7163.38 (6852.67-7794.41)
Males					
14 or under	429	2568.93	4714.97	5818.08	9350.89
15 - 44	702	1545.93	2854.49	3773.51	5254.04
45 or older	587	1451.06	2841.35	3366.84	5091.31
All ages	1718	1715.79 (1636.68-1794.90)	3399.26 (3290.97-3766.18)	4244.32 (4015.03-4581.61)	6818.35 (5792.54-7588.15)
Both Sexes					
14 or under	807	2624.35	5020.14	6904.83	10384.82
15 - 44	1654	1477.57	2798.37	3747.88	5386.43
45 or older	1466	1450.15	2839.04	3515.81	4922.99
All ages	3927	1674.31 (1606.79-1741.83)	3299.54 (3133.69-3462.35)	4258.69 (4065.32-4483.83)	7126.90 (6644.11-7794.41)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-28. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only Aged 18 Years and Older by Habitat - As Consumed

Milligrams/kilogram/person/day

Habitat	Statistic	Estimate	90% Interval Lower Bound	90% Interval Upper Bound
Fresh/Estuarine	Mean	959.15	867.58	1,050.72
n = 1,541	50th %	601.88	532.31	656.86
N = 37,166,000	90th %	2,442.97	2,233.16	2,606.66
	95th %	3,116.28	2,839.90	3,303.96
	99th %	5,151.98	4,432.30	6,931.61
Marine	Mean	1,270.78	1,214.65	1,326.90
n = 2,432	50th %	1,062.93	1,019.60	1,087.06
N = 57,830,000	90th %	2,467.68	2,331.88	2,585.09
	95th %	3,116.74	2,906.16	3,264.98
	99th %	4,250.22	4,037.74	4,387.96
All Fish	Mean	1,461.71	1,406.34	1,517.09
n = 3,007	50th %	1,189.29	1,156.77	1,225.43
N = 70,949,000	90th %	2,802.28	2,685.81	2,868.73
	95th %	3,588.11	3,308.93	3,798.54
	99th %	5,355.90	5,095.58	5,766.99

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Consumers only are individuals who consumed fish at least once during the 3-day reporting period; n = sample size; N = population size
Estimates are projected from a sample of consumers only 18 years of age and older to the population of consumers only 18 years of age and older using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conterminous states.
Source: U.S. EPA, 1996a.

Table 10-29. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	1.99 (1.34-2.64)	1.81 (0.00-4.63)	15.88 (7.89-18.38)	46.82 (36.72-54.55)
15 - 44	2891	5.50 (4.53-6.48)	13.62 (9.99-18.11)	36.68 (32.53-40.31)	94.93 (75.74-114.34)
45 or older	2340	6.65 (5.30-8.00)	24.18 (18.11-27.41)	46.91 (37.94-52.92)	108.90 (92.06-123.72)
All ages	6662	5.13 (4.37-5.88)	13.31 (10.48-16.67)	35.63 (28.92-40.07)	94.61 (77.70-109.09)
Males					
14 or under	1546	2.69 (1.62-3.76)	1.07 (0.33-8.67)	18.47 (14.39-25.91)	57.07 (47.32-65.37)
15 - 44	2151	7.87 (6.46-9.29)	22.10 (13.43-31.80)	63.26 (50.62-70.12)	126.61 (108.54-162.80)
45 or older	1553	8.87 (7.32-10.43)	28.74 (24.23-33.07)	61.15 (52.57-71.59)	125.90 (112.28-147.62)
All ages	5250	6.91 (6.07-7.75)	19.00 (14.99-23.69)	51.43 (47.32-54.82)	112.11 (108.54-127.19)
Both Sexes					
14 or under	2977	2.35 (1.70-3.00)	1.72 (0.00-5.00)	17.46 (12.78-18.68)	50.14 (43.58-55.00)
15 - 44	5042	6.64 (5.71-7.56)	18.30 (14.99-21.14)	47.31 (36.22-59.65)	109.66 (94.43-127.19)
45 or older	3893	7.66 (6.50-8.81)	26.11 (21.95-28.85)	52.92 (45.73-61.51)	113.10 (107.18-133.74)
All ages	11912	5.98(5.29-6.67)	15.89(14.39-17.76)	40.03(37.94-44.75)	107.63(98.25-109.09)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-30. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	8.61 (6.67-10.56)	31.23 (26.85-37.29)	49.75 (41.46-57.49)	104.26 (83.35-140.07)
15 - 44	2891	12.84 (11.51-14.18)	46.66 (38.35-54.30)	72.16 (63.12-77.18)	133.69 (121.33-142.82)
45 or older	2340	16.26 (14.68-17.84)	56.01 (50.00-61.97)	84.71 (75.05-93.29)	131.43 (112.07-156.01)
All ages	6662	13.05 (11.97-14.12)	46.70 (44.49-49.72)	72.22 (65.55-75.47)	130.73 (121.33-137.18)
Males					
14 or under	1546	9.40 (7.36-11.45)	31.32 (25.20-44.12)	65.37 (54.60-73.39)	118.42 (82.34-176.52)
15 - 44	2151	17.11 (15.31-18.90)	66.06 (62.21-73.20)	93.32 (81.26-106.67)	155.16 (136.77-181.18)
45 or older	1553	17.22 (15.19-19.25)	62.64 (59.39-68.44)	84.96 (79.93-99.44)	146.78 (142.58-185.44)
All ages	5250	15.27 (13.86-16.68)	61.12 (56.59-63.09)	81.89 (77.91-87.16)	147.09 (134.55-174.31)
Both Sexes					
14 or under	2977	9.02 (7.28-10.75)	31.52 (30.19-35.75)	56.35 (50.22-62.25)	117.75 (91.82-140.07)
15 - 44	5042	14.88 (13.57-16.19)	55.99 (53.04-61.33)	80.70 (75.19-87.16)	138.23 (128.40-157.23)
45 or older	3893	16.69 (15.34-18.04)	59.12 (52.84-64.53)	84.92 (76.67-93.32)	142.92 (134.55-155.13)
All ages	11912	14.11(13.07-15.14)	52.10(47.83-55.93)	76.51(74.58-80.89)	138.22(132.98-155.13)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-31. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	10.60 (8.40-12.81)	41.10 (35.80-47.57)	56.16 (49.78-65.55)	130.78 (83.35-160.66)
15 - 44	2891	18.35 (16.67-20.02)	62.21 (54.47-73.56)	93.13 (82.29-108.03)	155.75 (137.18-174.31)
45 or older	2340	22.91 (20.78-25.04)	74.56 (65.37-79.67)	107.66 (97.64-111.71)	159.97 (157.17-173.74)
All ages	6662	18.17 (16.82-19.53)	61.08 (56.94-63.12)	92.03 (86.94-96.11)	157.08 (147.34-168.83)
Males					
14 or under	1546	12.09 (9.70-14.49)	45.59 (34.69-53.11)	68.18 (64.28-79.90)	127.20 (87.29-176.52)
15 - 44	2151	24.98 (22.79-27.17)	87.15 (80.89-94.63)	122.29 (111.05-124.83)	197.15 (179.86-198.87)
45 or older	1553	26.09 (23.52-28.67)	81.76 (76.67-88.03)	112.33 (109.65-130.36)	211.20 (190.74-223.72)
All ages	5250	22.18 (20.52-23.83)	76.13 (74.22-79.92)	110.88 (108.54-118.56)	180.90 (174.39-198.87)
Both Sexes					
14 or under	2977	11.36 (9.49-13.24)	43.00 (34.69-47.32)	65.34 (56.28-68.51)	130.41 (107.12-160.66)
15 - 44	5042	21.51 (19.97-23.06)	75.15 (73.56-79.71)	109.57 (106.72-117.47)	175.73 (162.80-198.63)
45 or older	3893	24.35 (22.46-26.24)	77.57 (72.07-84.02)	110.13 (100.42-119.87)	180.74 (164.76-210.75)
All ages	11912	20.08(18.82-21.35)	70.11 (65.37-74.20)	102.01 (99.26-106.67)	173.18 (162.80-176.52)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-32. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for the U.S. Population Aged 18 Years and Older by Habitat - Uncooked Fish Weight

			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	7.09	6.22	7.96
	50th %	0.00	0.00	0.00
	90th %	21.72	18.52	25.82
	95th %	49.89	47.32	54.67
	99th %	111.13	107.18	116.38
Marine	Mean	16.01	14.89	17.12
	50th %	0.00	0.00	0.00
	90th %	59.35	56.59	61.49
	95th %	82.95	80.37	88.36
	99th %	142.78	131.02	156.89
All Fish	Mean	23.10	21.62	24.58
	50th %	0.00	0.00	0.00
	90th %	76.84	74.37	80.13
	95th %	110.28	106.67	115.32
	99th %	177.44	171.73	198.63

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
NOTE: Estimates are projected from a sample of 8,478 individuals of age 18 and older to the U.S. population of 177,807,000 individuals of age 18 and older using 3-year combined survey weights.
Source: U.S. EPA, 1996a.

Table 10-33. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	84.78 (58.06-111.50)	70.75 (0.00-143.13)	599.06 (266.71-722.58)	1713.06 (1511.78-2313.50)
15 - 44	2891	85.15 (70.68-99.62)	202.83 (153.48-259.97)	584.79 (538.05-631.86)	1411.42 (1236.72-1659.15)
45 or older	2340	98.97 (79.89-118.04)	333.38 (269.96-379.98)	733.74 (606.36-820.68)	1561.40 (1331.46-1667.88)
All ages	6662	89.54 (76.51-102.58)	225.51 (176.38-280.11)	625.30 (552.99-713.85)	1558.08 (1394.99-1659.15)
Males					
14 or under	1546	91.62 (55.18-128.05)	38.98 (12.26-281.50)	868.97 (485.33-1063.50)	1642.60 (1599.78-1693.88)
15 - 44	2151	96.91 (78.91-114.90)	281.17 (165.37-387.46)	740.91 (546.79-850.52)	1589.97 (1353.43-1992.23)
45 or older	1553	107.87 (88.47-127.28)	361.99 (304.96-455.29)	702.35 (628.25-810.62)	1612.49 (1344.07-1848.39)
All ages	5250	98.86 (87.19-110.52)	292.58 (217.42-342.11)	755.53 (677.47-790.85)	1596.61 (1538.89-1711.41)
Both Sexes					
14 or under	2977	88.26 (66.69-109.83)	66.00 (0.00-143.13)	717.37 (485.60-880.64)	1688.55 (1511.78-1824.44)
15 - 44	5042	90.77 (78.37-103.16)	250.26 (194.04-289.19)	631.31 (538.05-773.91)	1529.94 (1352.50-1659.15)
45 or older	3893	103.00 (87.86-118.15)	345.69 (291.80-423.39)	719.81 (637.94-790.85)	1590.13 (1373.97-1668.93)
All ages	11912	93.99 (83.41-104.57)	251.82 (222.54-282.58)	677.66 (631.86-729.11)	1593.28 (1511.78-1659.15)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-34. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	333.99 (267.25-400.72)	1132.99 (864.83-1407.24)	1959.91 (1780.61-2347.02)	3776.60 (3173.86-5736.90)
15 - 44	2891	206.03 (183.95-228.11)	762.54 (617.86-857.55)	1137.58 (1036.38-1211.86)	2174.21 (2014.41-2393.16)
45 or older	2340	246.73 (221.45-272.00)	829.52 (777.87-944.26)	1236.00 (1174.14-1413.34)	2161.65 (1952.51-2303.80)
All ages	6662	246.47 (223.28-269.66)	847.60 (811.19-893.29)	1305.49 (1215.53-1385.66)	2615.85 (2365.65-2857.62)
Males					
14 or under	1546	296.99 (241.85-352.13)	1089.46 (1003.46-1256.97)	1907.65 (1685.30-2186.58)	3723.81 (3274.93-4574.13)
15 - 44	2151	212.88 (190.31-235.44)	800.79 (741.29-859.61)	1191.75 (1096.61-1245.94)	1890.42 (1685.30-1969.63)
45 or older	1553	212.15 (187.25-237.04)	792.86 (747.56-890.31)	1100.20 (1039.02-1210.66)	1842.38 (1749.67-2219.32)
All ages	5250	233.07 (209.65-256.49)	859.01 (798.27-907.76)	1255.35 (1204.46-1382.05)	2520.94 (2263.58-2733.15)
Both Sexes					
14 or under	2977	315.12 (260.95-369.29)	1123.28 (993.12-1371.24)	1909.37 (1785.09-2062.64)	3820.21 (3370.59-4574.13)
15 - 44	5042	209.30 (190.68-227.92)	780.16 (722.86-843.41)	1174.69 (1104.42-1215.53)	2019.59 (1918.45-2237.22)
45 or older	3893	231.06 (212.18-249.95)	813.12 (747.56-907.76)	1193.22 (1076.85-1333.72)	2029.16 (1863.17-2219.32)
All ages	11912	240.07 (220.14-260.01)	855.63 (809.67-909.76)	1271.54 (1227.16-1371.24)	2575.29 (2393.16-2708.59)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-35. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population by Age and Gender - Uncooked Fish Weight (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	1431	418.76 (339.58-497.95)	1389.10 (1150.77-1785.09)	2341.90 (2062.64-2860.52)	4985.96 (3971.54-5736.90)
15 - 44	2891	291.18 (263.86-318.50)	993.92 (854.63-1127.32)	1436.00 (1234.66-1631.25)	2726.50 (2406.11-3044.81)
45 or older	2340	345.69 (312.49-378.90)	1122.26 (1050.15-1230.68)	1669.72 (1556.83-1784.37)	2684.71 (2303.80-3064.38)
All ages	6662	336.01 (307.83-364.20)	1120.91 (1054.05-1172.38)	1720.84 (1642.63-1855.69)	3093.76 (2973.66-3265.54)
Males					
14 or under	1546	388.61 (320.66-456.56)	1476.31 (1371.24-1632.55)	2038.58 (1909.00-2631.42)	4294.12 (3556.31-4574.13)
15 - 44	2151	309.78 (281.55-338.02)	1096.57 (1044.57-1194.06)	1566.39 (1410.20-1609.35)	2275.15 (2047.18-2465.77)
45 or older	1553	320.02 (287.79-352.25)	1013.05 (955.37-1096.43)	1459.73 (1340.97-1601.79)	2392.05 (2233.16-2806.51)
All ages	5250	331.93 (306.46-357.40)	1126.66 (1081.06-1225.66)	1621.80 (1599.78-1696.20)	3031.31 (2806.51-3274.93)
Both Sexes					
14 or under	2977	403.38 (343.65-463.12)	1442.72 (1279.82-1672.75)	2191.90 (2021.16-2536.75)	4425.27 (4000.27-4669.59)
15 - 44	5042	300.06 (277.94-322.19)	1040.98 (1003.55-1097.08)	1514.82 (1421.34-1572.40)	2481.23 (2383.54-2773.15)
45 or older	3893	334.07 (307.87-360.26)	1069.14 (978.95-1140.98)	1579.43 (1373.97-1696.20)	2653.45 (2292.45-2806.51)
All ages	11912	334.06 (311.25-356.88)	1123.14 (1090.76-1178.95)	1684.23 (1620.48-1718.51)	3092.77 (2973.66-3250.20)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Source: U.S. EPA, 1996a.

Table 10-36. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for the U.S. Population Aged 18 Years and Older by Habitat - Uncooked Fish Weight

Habitat	Statistic	Estimate	90% Interval	
			Lower Bound	Upper Bound
Fresh/Estuarine	Mean	95.99	84.30	107.69
	50th %	0.00	0.00	0.00
	90th %	306.74	259.97	334.58
	95th %	677.39	626.01	734.34
	99th %	1,547.81	1,411.56	1,599.78
Marine	Mean	222.86	207.34	238.37
	50th %	0.00	0.00	0.00
	90th %	810.43	778.50	859.61
	95th %	1,190.45	1,145.61	1,219.60
	99th %	2,033.92	1,870.09	2,263.58
All Fish	Mean	318.85	298.20	339.49
	50th %	0.00	0.00	0.00
	90th %	1,061.14	1,016.87	1,105.01
	95th %	1,548.77	1,464.72	1,609.14
	99th %	2,559.07	2,444.24	2,764.50

Percentile intervals were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
NOTE: Estimates are projected from a sample of 8,478 individuals of age 18 and older to the population of 177,807,000 individuals of age 18 and older using 3-year combined survey weights.
Source: U.S. EPA, 1996a.

Table 10-37. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - Uncooked Fish Weight (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	138	48.3	117.27	161.44	230.63
15 - 44	445	78.56	191.95	242.76	472.21
45 or older	453	78.77	192.32	258.56	368.84
All ages	1036	74.67 (65.46-83.88)	181.08 (171.19-197.59)	239.59 (220.69-284.70)	409.00 (345.96-671.54)
Males					
14 or under	157	64.91	141.35	193.79	287.28
15 - 44	356	104.86	269.96	343.66	494.38
45 or older	343	102.56	234.28	326.96	539.77
All ages	856	98.12 (88.60-107.64)	246.93 (212.93-283.90)	324.53 (283.28-381.58)	499.19 (488.41-532.32)
Both Sexes					
14 or under	295	56.95	134.89	166.32	262.87
15 - 44	801	91.66	237.27	322.06	494.64
45 or older	796	90	220.76	295.41	523.94
All ages	1892	86.19 (78.41-93.97)	217.92 (205.28-237.27)	290.04 (267.10-325.61)	489.29 (424.87-534.20)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-38. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - Uncooked Fish Weight (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	315	89.92	169.23	198.62	432.51
15 - 44	774	98.53	194.59	231.22	317.42
45 or older	715	110	214.73	279.67	345.37
All ages	1804	101.30 (95.90-106.69)	195.37 (186.67-213.33)	252.43 (231.53-278.16)	372.17 (314.67-428.00)
Males					
14 or under	348	101.5	205.49	242.28	408.68
15 - 44	565	133.86	244.46	297.67	393.14
45 or older	467	131.2	243.33	327.14	428.72
All ages	1380	126.85 (119.75-133.94)	238.64 (225.57-247.01)	296.68 (279.95-316.81)	425.98 (403.66-481.95)
Both Sexes					
14 or under	663	95.56	189.32	231.72	442.87
15 - 44	1339	115.41	223.99	263.76	383.16
45 or older	1182	119.08	226.55	288.16	418.23
All ages	3184	113.11 (107.79-118.43)	222.67 (216.50-225.56)	271.70 (260.62-279.95)	415.88 (367.26-440.45)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-39. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only by Age and Gender - Uncooked Fish Weight (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	378	89.73	163.47	204.14	476.56
15 - 44	952	114.04	220.63	277.69	461.54
45 or older	879	123.61	236.3	298.66	397.43
All ages	2209	113.58 (107.69-119.47)	220.44 (206.27-226.80)	287.08 (257.09-312.42)	448.57 (393.68-531.63)
Males					
14 or under	429	102.01	205.25	244.46	386.47
15 - 44	702	160.06	305.61	379.38	495.51
45 or older	587	152.52	292.95	350.26	555.11
All ages	1718	146.18 (138.99-153.38)	283.46 (261.72-297.95)	350.99 (328.70-382.33)	520.51 (488.41-591.47)
Both Sexes					
14 or under	807	96.07	195.35	232.85	466.09
15 - 44	1654	136.12	262.15	343.86	488.9
45 or older	1466	136.38	263.95	326.94	510.25
All ages	3927	129.00 (123.74-134.27)	249.09 (240.99-264.10)	326.00 (306.02-335.58)	497.54 (469.23-519.67)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-40. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (g/day) for Consumers Only Aged 18 Years and Older by Habitat - Uncooked Fish Weight

			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	89.88	81.41	98.35
n = 1,541	50th %	53.64	46.44	57.81
N = 37,166,000	90th %	223.11	206.58	237.27
	95th %	296.89	283.90	325.61
	99th %	502.93	448.23	654.55
Marine	Mean	117.83	112.47	123.20
n = 2,432	50th %	98.79	95.69	100.76
N = 57,830,000	90th %	225.51	222.67	234.00
	95th %	279.50	261.47	289.44
	99th %	403.48	369.10	427.73
All Fish	Mean	136.33	131.11	141.55
n = 3,007	50th %	111.50	108.53	112.00
N = 70,949,000	90th %	262.03	253.24	272.71
	95th %	328.66	323.61	340.52
	99th %	506.02	435.44	531.63

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Consumers only are individuals who consumed fish at least once during the 3-day reporting period; n = sample size; and N = population size. Estimates are projected from a sample of consumers only 18 years of age and older to the population of consumers only 18 years of age and older using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conterminous states.
Source: U.S. EPA, 1996a.

Table 10-41. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only by Age and Gender - Uncooked Fish Weight (Freshwater and Estuarine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	138	2070.41	4450.54	6915.31	13269.61
15 - 44	445	1229.97	3045.41	4191.25	7711.43
45 or older	453	1171.17	2886.48	3519.87	5577.34
All ages	1036	1317.18 (1150.10-1484.26)	3250.31 (2988.81-3491.38)	4240.89 (3710.16-5025.02)	8912.52 (6385.55-11533.98)
Males					
14 or under	157	2229.31	4638.34	5071.41	9622.15
15 - 44	356	1294.27	3318.89	4275.83	5974.96
45 or older	343	1235.55	2898.00	4097.24	7217.68
All ages	856	1411.35 (1278.61-1544.08)	3579.06 (3225.84-4060.30)	4615.66 (4121.91-5081.65)	6594.61 (5980.19-7944.55)
Both Sexes					
14 or under	295	2153.11	4634.82	5756.93	12388.27
15 - 44	801	1261.99	3276.06	4246.63	6625.15
45 or older	796	1201.57	2892.52	3981.84	6378.11
All ages	1892	1363.44 (1242.24-1484.65)	3325.14 (3232.58-3676.99)	4408.18 (4085.55-4781.34)	7957.50 (6979.20-8920.99)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-42. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only by Age and Gender - Uncooked Fish Weight (Marine)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females	0	0	0	0	0
14 or under	315	3359.10	6058.97	8573.62	13050.09
15 - 44	774	1582.77	3129.41	3854.14	5961.80
45 or older	715	1669.73	3429.24	4397.07	5476.02
All ages	1804	1920.77 (1804.28-2037.26)	3793.20 (3618.55-4328.00)	5083.63 (4953.40-5552.65)	8576.60 (7527.83-9743.01)
Males	0	0	0	0	0
14 or under	348	3180.45	6434.20	8089.26	10764.01
15 - 44	565	1666.42	3102.24	3651.10	4998.14
45 or older	467	1604.71	2931.17	3725.63	5373.82
All ages	1380	1934.12 (1812.97-2055.28)	3736.16 (3548.08-4072.42)	4884.60 (4454.15-5710.83)	8066.96 (6852.67-9869.52)
Both Sexes	0	0	0	0	0
14 or under	663	3272.13	6278.74	8424.77	11838.54
15 - 44	1339	1622.75	3120.60	3682.17	5517.95
45 or older	1182	1641.87	3320.87	4328.34	5406.76
All ages	3184	1926.95 (1829.50-2024.39)	3752.89 (3631.98-4001.16)	5018.74 (4852.08-5267.31)	8448.28 (7215.72-9136.89)

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-43. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumer Only by Age and Gender - Uncooked Fish Weight (All Fish)

Age	Sample Size	Mean (90% C.I.)	90th % (90% B.I.)	95th % (90% B.I.)	99th % (90% B.I.)
Females					
14 or under	378	3448.73	7100.43	9012.18	15381.13
15 - 44	952	1818.32	3506.20	4661.96	8789.33
45 or older	879	1857.64	3520.90	4740.11	6561.13
All ages	2209	2102.20	4092.51	5545.07	9630.23 (8166.44-9796.61)
		(1982.89-2221.51)	(3842.15-4282.08)	(5080.72-6007.28)	
Males					
14 or under	429	3273.63	5734.46	7570.83	11891.85
15 - 44	702	1983.16	3720.05	4769.44	6121.56
45 or older	587	1850.69	3534.61	4311.83	6374.34
All ages	1718	2193.24	4385.06	5351.38	8596.82 (7816.70-10199.24)
		(2089.20-2297.28)	(4121.91-4776.34)	(5055.10-5727.01)	
Both Sexes					
14 or under	807	3358.33	6333.46	8611.73	12406.35
15 - 44	1654	1897.40	3674.88	4709.78	7276.18
45 or older	1466	1854.57	3522.43	4615.22	6440.17
All ages	3927	2145.26	4223.91	5477.86	9171.52 (8605.35-9796.61)
		(2055.92-2234.61)	(4085.76-4454.15)	(5163.33-5686.04)	

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Consumers only are individuals with reported fish consumption at least once during the three day reporting period.
Source: U.S. EPA, 1996a.

Table 10-44. Per Capita Distribution of Fish (Finfish and Shellfish) Intake (mg/kg-day) for Consumers Only Aged 18 Years and Older by Habitat - Uncooked Fish Weight

			90% Interval	
Habitat	Statistic	Estimate	Lower Bound	Upper Bound
Fresh/Estuarine	Mean	1,216.82	1,101.74	1,331.90
n = 1,541	50th %	740.93	639.11	822.65
N = 37,166,000	90th %	3,050.95	2,931.26	3,270.80
	95th %	4,025.44	3,639.76	4,121.91
	99th %	6,638.62	6,007.28	8,920.99
Marine	Mean	1,637.10	1,564.27	1,709.92
n = 2,432	50th %	1,370.42	1,302.29	1,422.69
N = 57,830,000	90th %	3,169.02	3,006.55	3,328.98
	95th %	3,926.74	3,632.70	4,156.98
	99th %	5,452.75	5,353.12	5,596.31
All Fish	Mean	1,873.84	1,801.93	1,945.75
n = 3,007	50th %	1,515.91	1,477.99	1,570.40
N = 70,949,000	90th %	3,599.04	3,443.64	3,676.99
	95th %	4,665.15	4,264.03	4,812.97
	99th %	7,022.47	6,459.64	7,294.80

Percentile intervals (B.I.) were estimated using the percentile bootstrap method with 1,000 bootstrap replications.
Note: Consumers only are individuals who consumed fish at least once during the 3-day reporting period; n = sample size; and N = population size. Estimates are projected from a sample of consumers only 18 years of age and older to the population of consumers only 18 years of age and older using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conterminous states.
Source: U.S. EPA, 1996a.

Table 10-45. Distribution of Quantity of Fish Consumed (in grams) Per Eating Occasion, by Age and Sex

			Percentiles						
Age (years)-Sex Group	Mean	SD	5th	25th	50th	75th	90th	95th	99th
1-2 Male-Female	52	38	8	28	43	58	112	125	168
3-5 Male-Female	70	51	12	36	57	85	113	170	240
6-8 Male-Female	81	58	19	40	72	112	160	170	288
9-14 Male	101	78	28	56	84	113	170	255	425
9-14 Female	86	62	19	45	79	112	168	206	288
15-18 Male	117	115	20	57	85	142	200	252	454
15-18 Female	111	102	24	56	85	130	225	270	568
19-34 Male	149	125	28	64	113	196	284	362	643
19-34 Female	104	74	20	57	85	135	184	227	394
35-64 Male	147	116	28	80	113	180	258	360	577
35-64 Female	119	98	20	57	85	152	227	280	480
65-74 Male	145	109	35	75	113	180	270	392	480
65-74 Female	123	87	24	61	103	168	227	304	448
75+ Male	124	68	36	80	106	170	227	227	336
75+ Female	112	69	20	61	112	151	196	225	360
Overall	117	98	20	57	85	152	227	284	456

Source: Pao et al., 1982.

Table 10-46. Mean Fish Intake in a Day, by Sex and Age[a]

Sex Age (year)	Per capita intake (g/day)	Percent of population consuming fish in 1 day	Mean intake (g/day) for consumers only[b]
Males or Females 5 and under	4	6.0	67
Males	3	3.7	79
6-11	3	2.2	136
12-19	15	10.9	138
20 and over			
Females	7	7.1	99
6-11	9	9.0	100
12-19	12	10.9	110
20 and over			
All individuals	11	9.4	117

[a] Based on USDA Nationwide Food Consumption Survey 1987-88 data for one day.
[b] Intake for users only was calculated by dividing the per capita consumption rate by the fraction of the population consuming fish in one day.
Source: USDA, 1992b.

Table 10-47. Percent of Respondents That Responded Yes, No, or Don't Know to Eating Seafood in 1 Month (including shellfish, eels, or squid)

Population Group	Total N	Response					
		No		Yes		DK	
		N	%	N	%	N	%
Overall	4663	1811	38.8	2780	59.6	72	1.5
Gender							
*	2	1	50.0	1	50.0	*	*
Male	2163	821	38.0	1311	60.6	31	1.4
Female	2498	989	39.6	1468	58.8	41	1.6
Age (years)							
*	84	25	29.8	42	50.0	17	20.2
1-4	263	160	60.8	102	38.8	1	0.4
5-11	348	177	50.9	166	47.7	5	1.4
12-17	326	179	54.9	137	42.0	10	3.1
18-64	2972	997	33.5	1946	65.5	29	1.0
>64	670	273	40.7	387	57.8	10	1.5
Race							
*	60	20	33.3	22	36.7	18	30.0
White	3774	1475	39.1	2249	59.6	50	1.3
Black	463	156	33.7	304	65.7	3	0.6
Asian	77	21	27.3	56	72.7	*	*
Some Others	96	39	40.6	56	58.3	1	1.0
Hispanic	193	100	51.8	93	48.2	*	*
Hispanic							
*	46	10	21.7	412	43.0	28	41.3
No	4243	1625	31.2	1366	67.7	21	1.2
Yes	348	165	35.4	236	62.3	9	*
DK	26	11	40.4	766	58.5	14	*
Employment							
*	958	518	54.1	412	43.0	28	2.9
Full Time	2017	630	31.2	1366	67.7	21	1.0
Part Time	379	134	35.4	236	62.3	9	2.4
Not Employed	1309	529	40.4	766	58.5	14	1.1
Education							
*	1021	550	53.9	434	42.5	37	3.6
< High School	399	196	49.1	198	49.6	45	1.3
High School Graduate	1253	501	40.0	739	59.0	13	1.0
< College	895	304	34.0	584	65.3	7	0.8
College Graduate	650	159	24.5	484	74.5	7	1.1
Post Graduate	445	101	22.7	341	76.6	3	0.7
Census Region							
Northeast	1048	370	35.3	655	62.5	23	2.2
Midwest	1036	449	43.3	575	55.5	12	1.2
South	1601	590	36.9	989	61.8	22	1.4
West	978	402	41.1	561	57.4	15	1.5
Day of Week							
Weekday	3156	1254	39.7	1848	58.6	54	1.7
Weekend	1507	557	37.0	932	61.8	18	1.2
Season							
Winter	1264	462	36.6	780	61.7	22	1.7
Spring	1181	469	39.7	691	58.5	21	1.8
Summer	1275	506	39.7	745	58.4	24	1.9
Fall	943	374	39.7	564	59.8	5	0.5
Asthma							
No	4287	1674	39.0	2563	59.8	50	1.2
Yes	341	131	38.4	207	60.7	3	0.9
DK	35	6	17.7	10	28.6	19	54.3
Angina							
No	4500	1750	38.9	2698	60.0	52	1.2
Yes	125	56	44.8	68	54.4	1	0.8
DK	38	50	13.2	14	36.8	19	50.0
Bronchitis/Emphysema							
No	4424	1726	9.0	2648	59.6	50	1.1
Yes	203	80	39.4	121	59.6	2	1.0
DK	36	5	13.9	11	30.6	20	55.6

Note: * = Missing data; DK = Don't know; % = Row percentage; N = Sample size
Source: Tsang and Klepeis, 1996.

Table 10-48. Number of Respondents Reporting Consumption of a Specified Number of Servings of Seafood in 1 Month

Population Group	Total N	Number of Servings in a Month					
		1-2	3-5	6-10	11-19	20+	DK
Overall	2780	918	990	519	191	98	64
Gender							
*	1311	405	458	261	101	57	29
Male	1468	512	532	258	90	41	35
Female	1	1	*	*	*	*	*
Age (years)							
*	42	13	16	5	4	1	3
1-4	102	55	29	12	2	*	4
5-11	166	72	57	21	6	4	6
12-17	137	68	54	9	2	1	3
18-64	1946	603	679	408	145	79	32
>64	387	107	155	64	32	13	16
Race							
*	2249	731	818	428	155	76	41
White	304	105	103	56	16	10	14
Black	56	15	17	11	5	5	3
Asian	56	22	18	6	5	3	2
Some Others	93	41	25	14	9	2	2
Hispanic	22	4	9	4	1	2	2
Hispanic							
*	2566	844	922	480	175	88	57
No	182	68	52	34	15	8	5
Yes	15	5	8	2	*	*	*
DK	17	1	8	3	1	2	2
Employment							
*	399	190	140	40	11	5	13
Full Time	1366	407	466	307	107	57	22
Part Time	236	70	95	46	14	8	3
Not Employed	766	249	285	124	57	26	25
Refused	13	2	4	2	2	2	1
Education							
*	434	205	149	47	12	7	14
< High School	198	88	62	20	6	10	12
High School Graduate	739	267	266	119	46	21	20
< College	584	161	219	122	48	26	8
College Graduate	484	115	183	121	43	17	5
Post Graduate	341	82	111	90	36	17	5
Census Region							
Northeast	655	191	241	137	62	12	12
Midwest	575	199	221	102	17	22	14
South	989	336	339	175	70	41	28
West	561	192	189	105	42	23	10
Day of Week							
Weekday	1848	602	661	346	129	70	40
Weekend	932	316	329	173	62	28	24
Season							
Winter	780	262	284	131	60	28	15
Spring	691	240	244	123	45	25	14
Summer	745	220	249	160	59	31	26
Fall	564	196	213	105	27	14	9
Asthma							
No	2563	846	917	475	180	88	57
Yes	207	69	71	42	11	9	5
DK	10	3	2	2	*	1	2
Angina							
No	2698	896	960	509	183	95	55
Yes	68	19	27	8	7	1	6
DK	14	3	3	2	1	2	3
Bronchitis/Emphysema							
No	2648	877	940	495	185	91	60
Yes	121	37	47	23	6	6	2
DK	11	4	3	1	*	1	2

Note: * = Missing data; DK = Don't know; % = Row percentage; N = Sample size; Refused = Respondent refused to answer.
Source: Tsang and Klepeis, 1996.

Table 10-49. Numer of Respondents Reporting Monthly Consumption of Seafood That Was Purchased or Caught by Someone They Knew

Population Group	Total N	*	Mostly Purchased	Mostly Caught	DK
Overall	2780	3	2584	154	39
Gender					
*	1311	1	1206	85	19
Male	1468	2	1377	69	20
Female	1	*	1	*	*
Age (years)					
*	42	*	39	3	*
1-4	102	*	94	8	*
5-11	166	*	153	9	4
12-17	137	*	129	6	2
18-64	1946	3	1810	106	27
>64	387	*	359	22	6
Race					
*	2249	1	2092	124	32
White	304	1	280	19	4
Black	56	*	50	4	2
Asian	56	*	55	*	1
Some Others	93	*	86	7	*
Hispanic	22	1	21	*	*
Hispanic					
*	2566	2	2387	140	37
No	182	*	169	13	*
Yes	15	*	12	1	2
DK	17	1	16	*	*
Employment					
*	399	*	368	25	6
Full Time	1366	2	1285	64	15
Part Time	236	1	217	15	3
Not Employed	766	*	701	50	15
Refused	13	*	13	*	*
Education					
*	434	*	401	26	7
< High School	198	*	174	20	4
High School Graduate	739	*	680	48	11
< College	584	2	547	28	7
College Graduate	484	*	460	19	5
Post Graduate	341	1	322	13	5
Census Region					
Northeast	655	2	627	21	5
Midwest	575	*	547	20	8
South	989	1	897	73	18
West	561	*	513	40	8
Day of Week					
Weekday	1848	2	1724	100	22
Weekend	932	1	860	54	17
Season					
Winter	780	*	741	35	4
Spring	691	*	655	27	9
Summer	745	2	674	54	15
Fall	564	1	514	38	11
Asthma					
No	2563	2	2384	142	35
Yes	207	1	190	12	4
DK	10	*	10	*	*
Angina					37
No	2698	3	2507	151	2
Yes	68	*	63	3	*
DK	14	*	14	*	
Bronchitis/Emphysema					
No	2648	3	2457	149	39
Yes	121	*	116	5	*
DK	11	*	11	*	*

Note: * = Missing data; DK = Don't know; N = Sample size; Refused = Respondent refused to answer.
Source: Tsang and Klepeis, 1996.

Table 10-50. Estimated Number of Participants in Marine Recreational Fishing by State and Subregion

Subregion	State	Coastal Participants	Non Coastal Participants	Out of State [a]	Total Participants [a]
Pacific	So. California	902	8	159	910
	N. California	534	99	63	633
	Oregon	265	19	78	284
	TOTAL	1,701	126		
North Atlantic	Connecticut	186	*[b]	47	186
	Maine	93	9	100	102
	Massachusetts	377	69	273	446
	New Hampshire	34	10	32	44
	Rhode Island	97	*	157	97
	TOTAL	787	88		
Mid-Atlantic	Delaware	90	*	159	90
	Maryland	540	32	268	572
	New Jersey	583	9	433	592
	New York	539	13	70	552
	Virginia	294	29	131	323
	TOTAL	1,046	83		
South Atlantic	Florida	1,201	*	741	1,201
	Georgia	89	61	29	150
	N. Carolina	398	224	745	622
	S. Carolina	131	77	304	208
	TOTAL	1,819	362		
Gulf of Mexico	Alabama	95	9	101	104
	Florida	1,053	*	1,349	1,053
	Louisiana	394	48	63	442
	Mississippi	157	42	51	200
	TOTAL	1,699	99		
	GRAND TOTAL	8,053	760		

[a] Not additive across states. One person can be counted as "OUT OF STATE" for more than one state.
[b] An asterisk (*) denotes no non-coastal counties in state.
Source: NMFS, 1993.

Table 10-51. Estimated Weight of Fish Caught (Catch Type A and B1) by Marine Recreational Fishermen, by Wave and Subregion

	Atlantic and Gulf		Pacific	
	Region	Weight (1000 kg)	Region	Weight (1000 kg)
Jan/Feb	South Atlantic	1,060	So. California	418
	Gulf	3,683	N. California	101
			Oregon	165
	TOTAL	4,743	TOTAL	684
Mar/Apr	North Atlantic	310	So. California	590
	Mid Atlantic	1,030	N. California	346
	South Atlantic	1,913	Oregon	144
	Gulf	3,703	TOTAL	1,080
	TOTAL	6,956		
			So.California	1,195
May/Jun	North Atlantic	3,272	N. California	563
	Mid Atlantic	4,815	Oregon	581
	South Atlantic	4,234	TOTAL	2,339
	Gulf	5,936		
	TOTAL	18,257	So. California	1,566
			N. California	1,101
Jul/Aug	North Atlantic	4,003	Oregon	39
	Mid Atlantic	9,693	TOTAL	2,706
	South Atlantic	4,032		
	Gulf	5,964	So. California	859
	TOTAL	23,692	N. California	1,032
			Oregon	724
Sep/Oct	North Atlantic	2,980	TOTAL	2,615
	Mid Atlantic	7,798		
	South Atlantic	3,296	So. California	447
	Gulf	7,516	N. California	417
	TOTAL	21,590	Oregon	65
			TOTAL	929
Nov/Dec	North Atlantic	456		
	Mid Atlantic	1,649	GRAND TOTAL	10,353
	South Atlantic	2,404		
	Gulf	4,278		
	TOTAL	8,787		
	GRAND TOTAL	84,025		

Source: NMFS, 1993.

Table 10-52. Average Daily Intake (g/day) of Marine Finfish, by Region and Coastal Status

	Intake Among Anglers				
Region[a]	Mean	95th Percentile	Per-Capita (Coastal)[b]	Per-Capita (Coastal & Non-Coastal)[c]	Proportion of Population Coastal
N. Atlantic	6.2	20.1	1.2	1.1	0.82
Mid-Atlantic	6.3	18.9	1.2	0.9	0.70
S. Atlantic	4.7	15.9	1.5	1.0	0.51
All Atlantic	5.6	18.0	1.3	0.9	0.66
Gulf	7.2	26.1	3.0	1.9	0.60
S. California	2.0	5.5	0.2	0.2	0.96
N. California	2.0	5.7	0.3	0.3	0.70
Oregon	2.2	8.9	0.5	0.5	0.87
All Pacific	2.0	6.8	0.3	0.3	0.86

[a] N. Atlantic - ME, NH, MA, RI, and CT; Mid-Atlantic - NY, NJ, MD, DE, and VA; S. Atlantic - NC, SC, GA, and FL (Atlantic Coast); Gulf - AL, MS, LA, and FL (Gulf Coast).

[b] Mean intake rate among entire coastal population of region.

[c] Mean intake rate among entire population of region.

Source: NMFS, 1993.

Table 10-53. Estimated Weight of Fish Caught (Catch Type A and B1)[a] by Marine Recreational Fishermen by Species Group and Subregion, Atlantic and Gulf

	North Atlantic (1,000 kg)	Mid Atlantic (1,000 kg)	South Atlantic (1,000 kg)	Gulf (1,000 kg)	All Regions (1,000 kg)
Cartilaginous fishes	66	1,673	162	318	2,219
Eels	14	9	*[b]	0[c]	23
Herrings	118	69	1	89	177
Catfishes	0	306	138	535	979
Toadfishes	0	7	0	*	7
Cods and Hakes	2,404	988	4	0	1,396
Searobins	2	68	*	*	70
Sculpins	1	*	0	0	1
Temperate Basses	837	2,166	22	4	2,229
Sea Basses	22	2,166	644	2,477	5,309
Bluefish	4,177	3,962	1,065	158	5,362
Jacks	0	138	760	2,477	3,375
Dolphins	65	809	2,435	1,599	4,908
Snappers	0	*	508	3,219	3,727
Grunts	0	9	239	816	1,064
Porgies	132	417	1,082	2,629	4,160
Drums	3	2,458	2,953	9,866	15,280
Mullets	1	43	382	658	1,084
Barracudas	0	*	356	244	600
Wrasses	783	1,953	46	113	2,895
Mackerels and Tunas	878	3,348	4,738	4,036	13,000
Flounders	512	4,259	532	377	5,680
Triggerfishes/Filefishes	0	48	109	544	701
Puffers	*	16	56	4	76
Other fishes	105	72	709	915	1,801

[a] For Catch Type A and B1, the fish were not thrown back.

[b] An asterisk (*) denotes data not reported.

[c] Zero (0) = < 1000 kg.

Source: NMFS, 1993.

Table 10-54. Estimated Weight of Fish Caught (Catch Type A and B1)[a] by Marine Recreational Fishermen by Species Group and Subregion, Pacific

Species Group	Southern California (1,000 kg)	Northern California (1,000 kg)	Oregon (1,000 kg)	Total
Cartilaginous fish	35	162	1	198
Sturgeons	0[b]	89	13	102
Herrings	10	15	40	65
Anchovies	*[c]	7	0	7
Smelts	0	71	0	71
Cods and Hakes	0	0	0	0
Silversides	58	148	0	206
Striped Bass	0	51	0	51
Sea Basses	1,319	17	0	1,336
Jacks	469	17	1	487
Croakers	141	136	0	277
Sea Chubs	53	1	0	54
Surfperches	74	221	47	342
Pacific Barracuda	866	10	0	876
Wrasses	73	5	0	78
Tunas and Mackerels	1,260	36	1	1,297
Rockfishes	409	1,713	890	3,012
California Scorpionfish	86	0	0	86
Sablefishes	0	0	5	5
Greenlings	22	492	363	877
Sculpins	6	81	44	131
Flatfishes	106	251	5	362
Other fishes	89	36	307	432

[a] For Catch Type A and B1, the fish were not thrown back.
[b] Zero (0) = <1000 kg.
[c] An asterisk (*) denotes data not reported.
Source: NMFS, 1993.

Table 10-55. Median Intake Rates Based on Demographic Data of Sport Fishermen and Their Family/Living Group

	Percent of total interviewed	Median intake rates (g/person-day)
Ethnic Group		
Caucasian	42	46.0
Black	24	24.2
Mexican-American	16	33.0
Oriental/Samoan	13	70.6
Other	5	--[a]
Age (years)		
< 17	11	27.2
18 - 40	52	32.5
41 - 65	28	39.0
> 65	9	113.0

[a] Not reported.
Source: Puffer et al., 1981.

Table 10-56. Cumulative Distribution of Total Fish/Shellfish Consumption by Surveyed Sport Fishermen in the Metropolitan Los Angeles Area

Percentile	Intake rate (g/person-day)
5	2.3
10	4.0
20	8.3
30	15.5
40	23.9
50	36.9
60	53.2
70	79.8
80	120.8
90	224.8
95	338.8

Source: Puffer et al. (1981).

Table 10-57. Catch Information for Primary Fish Species Kept by Sport Fishermen (n = 1059)

Species	Average Weight (Grams)	Percent of Fishermen who Caught
White Croaker	153	34
Pacific Mackerel	334	25
Pacific Bonito	717	18
Queenfish	143	17
Jacksmelt	223	13
Walleye Perch	115	10
Shiner Perch	54	7
Opaleye	307	6
Black Perch	196	5
Kelp Bass	440	5
California Halibut	1752	4
Shellfish[a]	421	3

[a] Crab, mussels, lobster, abalone.
Source: Modified from Puffer et al., 1981.

Table 10-58. Percent of Fishing Frequency During the Summer and Fall Seasons in Commencement Bay, Washington

Fishing Frequency	Frequency Percent in the Summer[a]	Frequency Percent in the Fall[b]	Frequency Percent in the Fall[c]
Daily	10.4	8.3	5.8
Weekly	50.3	52.3	51.0
Monthly	20.1	15.9	21.1
Bimonthly	6.7	3.8	4.2
Biyearly	4.4	6.1	6.3
Yearly	8.1	13.6	11.6

[a] Summer - July through September, includes 5 survey days and 4 survey areas (i.e., area #1, #2, #3 and #4)
[b] Fall - September through November, includes 4 survey days and 4 survey areas (i.e., area #1, #2, #3 and #4)
[c] Fall - September through November, includes 4 survey days described in footnote [b] plus an additional survey area (5 survey areas) (i.e., area #1, #2, #3, #4 and #5)
Source: Pierce et al., 1981.

Table 10-59. Selected Percentile Consumption Estimates (g/day) for the Survey and Total Angler Populations Based on the Reanalysis of the Puffer et al. (1981) and Pierce et al. (1981) Data

	50th Percentile	90th Percentile
Survey Population		
Puffer et al. (1981)	37	225
Pierce et al. (1981)	19	155
Average	28	190
Total Angler Population		
Puffer et al. (1981)	2.9[a]	35[b]
Pierce et al. (1981)	1.0	13
Average	2.0	24

[a] Estimated based on the average intake for the 0 - 90th percentile anglers.
[b] Estimated based on the average intake for the 91st - 96th percentile anglers.
Source: Price et al., 1994.

Table 10-60. Means and Standard Deviations of Selected Characteristics by Subpopulation Groups in Everglades, Florida

Variables (N^a=330)	Mean ± Std. Dev.[b]	Range
Age (years)	38.6 ± 18.8	2 - 81
Sex		
Female	38%	--
Male	62%	--
Race/ethnicity		
Black	46%	--
White	43%	--
Hispanic	11%	--
Number of Years Fished	15.8 ± 15.8	0 - 70
Number Per Week Fished in Past 6 Months of Survey Period	1.8 ± 2.5	0 - 20
Number Per Week Fished in Last Month of Survey Period	1.5 ± 1.4	0 - 12
Aware of Health Advisories	71%	--

[a] Number of respondents who reported consuming fish
[b] Std. Dev. = standard deviation
Source: U.S. DHHS, 1995

Table 10-61. Mean Fish Intake Among Individuals Who Eat Fish and Reside in Households With Recreational Fish Consumption

Group	All Fish meals/week	Recreational Fish meals/week	n	Total Fish grams/day	Recreational Fish grams/day	Total Fish grams/ kg/day	Recreational Fish grams/ kg/day
All household members	0.686	0.332	2196	21.9	11.0	0.356	0.178
Respondents (i.e., licensed anglers)	0.873	0.398	748	29.4	14.0	0.364	0.168
Age Groups (years)							
1-5	0.463	0.223	121	11.4	5.63	0.737	0.369
6 to 10	0.49	0.278	151	13.6	7.94	0.481	0.276
1 to 20	0.407	0.229	349	12.3	7.27	0.219	0.123
21 to 40	0.651	0.291	793	22	10.2	0.306	0.139
40 to 60	0.923	0.42	547	29.3	14.2	0.387	0.186
60 to 70	0.856	0.431	160	28.2	14.5	0.377	0.193
71 to 80	1.0	0.622	45	32.3	20.1	0.441	0.271
80+	0.8	0.6	10	26.5	20	0.437	0.345

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-62. Comparison of Seven-Day Recall and Estimated Seasonal Frequency for Fish Consumption

Usual Fish Consumption Frequency Category	Mean Fish Meals/Week 7-day Recall Data	Usual frequency Value Selected for Data Analysis (times/week)
Almost daily	no data	4 [if needed]
2-4 times a week	1.96	2
Once a week	1.19	1.2
2-3 times a month	0.840 (3.6 times/month)	0.7 (3 times/month)
Once a month	0.459 (1.9 times/month)	0.4 (1.7 times/month)
Less often	0.306 (1.3 times/month)	0.2 (0.9 times/month)

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-63. Distribution of Usual Fish Intake Among Survey Main Respondents Who Fished and Consumed Recreationally Caught Fish

	All Fish Meals/Week	Recreational Fish Meals/Week	All Fish Intake grams/day	Recreational Fish Intake grams/day	All Fish Intake grams/ kg/day	Recreational Fish Intake grams/kg/day
n	738	738	738	738	726	726
mean	0.859	0.447	27.74	14.42	0.353	0.1806
10%	0.300	0.040	9.69	1.29	0.119	0.0159
25%	0.475	0.125	15.34	4.04	0.187	0.0504
50%	0.750	0.338	24.21	10.90	0.315	0.1357
75%	1.200	0.672	38.74	21.71	0.478	0.2676
90%	1.400	1.050	45.20	33.90	0.634	0.4146
95%	1.800	1.200	58.11	38.74	0.747	0.4920

Source: U.S. EPA analysis using data from West et al., 1989.

Table 10-64. Estimates of Fish Intake Rates of Licensed Sport Anglers in Maine During the 1989-1990 Ice Fishing or 1990 Open-Water Seasons[a]

Percentile Rankings	Intake Rates (grams/day)			
	All Waters[b]		Rivers and Streams	
	All Anglers[c] (N = 1,369)	Consuming Anglers[d] (N = 1,053)	River Anglers[e] (N = 741)	Consuming Anglers[d] (N = 464)
50th (median)	1.1	2.0	0.19	0.99
66th	2.6	4.0	0.71	1.8
75th	4.2	5.8	1.3	2.5
90th	11.0	13.0	3.7	6.1
95th	21.0	26.0	6.2	12.0
Arithmetic Mean[f]	5.0 [79]	6.4 [77]	1.9 [82]	3.7 [81]

[a] Estimates are based on rank except for those of arithmetic mean.
[b] All waters based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.
[c] Licensed anglers who fished during the seasons studied and did or did not consume freshwater fish, and licensed anglers who did not fish but ate freshwater fish caught in Maine during those seasons.
[d] Licensed anglers who consumed freshwater fish caught in Maine during the seasons studied.
[e] Those of the "all anglers" who fished on rivers or streams (consumers and nonconsumers).
[f] Values in brackets [ ] are percentiles at the mean consumption rates.
Source: Chemrisk, 1991; Ebert et al., 1993.

Table 10-65. Analysis of Fish Consumption by Ethnic Groups for "All Waters" (g/day)[a]

	Consuming Anglers[b]					
	French Canadian Heritage	Irish Heritage	Italian Heritage	Native American Heritage	Other White Non-Hispanic Heritage	Scandinavian Heritage
N of Cases	201	138	27	96	533	37
Median (50th percentile)[c,d]	2.3	2.4	1.8	2.3	1.9	1.3
66th percentile[c,d]	4.1	4.4	2.6	4.7	3.8	2.6
75th percentile[c,d]	6.2	6.0	5.0	6.2	5.7	4.9
Arithmetic Mean[c]	7.4	5.2	4.5	10	6.0	5.3
Percentile at the Mean[d]	80	70	74	83	76	78
90th percentile[c,d]	15	12	12	16	13	9.4
95th percentile[c,d]	27	20	21	51	24	25
Percentile at 6.5 g/day[d,e]	77	75	81	77	77	84

[a] "All Waters" based on fish obtained from all lakes, ponds, streams and rivers in Maine, from other household sources and from other non-household sources.
[b] "Consuming Anglers" refers to only those anglers who consumed freshwater fish obtained from Maine sources during the 1989-1990 ice fishing or 1990 open water fishing season.
[c] The average consumption per day by freshwater fish consumers in the household.
[d] Calculated by rank without any assumption of statistical distribution.
[e] Fish consumption rate recommended by U.S. EPA (1984) for use in establishing ambient water quality standards.
Source: Chemrisk, 1991.

Table 10-66. Total Consumption of Freshwater Fish Caught by All Survey Respondents During the 1990 Season

Species	Ice Fishing		Lakes and Ponds		Rivers and Streams	
	Quantity Consumed (#)	Grams ($x10^3$) Consumed	Quantity Consumed (#)	Grams ($x10^3$) Consumed	Quantity Consumed (#)	Grams ($x10^3$) Consumed
Landlocked salmon	832	290	928	340	305	120
Atlantic salmon	3	1.1	33	9.9	17	11
Togue (Lake trout)	483	200	459	160	33	2.7
Brook trout	1,309	100	3,294	210	10,185	420
Brown trout	275	54	375	56	338	23
Yellow perch	235	9.1	1,649	52	188	7.4
White perch	2,544	160	6,540	380	3,013	180
Bass (smallmouth and largemouth)	474	120	73	5.9	787	130
Pickerel	1,091	180	553	91	303	45
Lake whitefish	111	20	558	13	55	2.7
Hornpout (Catfish and bullheads)	47	8.2	1,291	100	180	7.8
Bottom fish (Suckers, carp and sturgeon)	50	81	62	22	100	6.7
Chub	0	0	252	35	219	130
Smelt	7,808	150	428	4.9	4,269	37
Other	201	210	90	110	54	45
TOTALS	**15,463**	**1,583.4**	**16,587**	**1,590**	**20,046**	**1,168**

Source: Chemrisk, 1991.

Table 10-67. Mean Sport-Fish Consumption by Demographic Variables, Michigan Sport Anglers Fish Consumption Study, 1991-1992

	N	Mean (g/day)	95% C.I.
Income[a]			
<$15,000	290	21.0	16.3 - 25.8
$15,000 - $24,999	369	20.6	15.5 - 25.7
$25,000 - $39,999	662	17.5	15.0 - 20.1
>$40,000	871	14.7	12.8 - 16.7
Education			
Some High School	299	16.5	12.9 - 20.1
High School Degree	1,074	17.0	14.9 - 19.1
Some College-College Degree	825	17.6	14.9 - 20.2
Post Graduate	231	14.5	10.5 - 18.6
Residence Size[b]			
Large City/Suburb (>100,000)	487	14.6	11.8 - 17.3
Small City (20,000-100,000)	464	12.9	10.7 - 15.0
Town (2,000-20,000)	475	19.4	15.5 - 23.3
Small Town (100-2,000)	272	22.8	16.8 - 28.8
Rural, Non Farm	598	17.7	15.1 - 20.3
Farm	140	15.1	10.3 - 20.0
Age (years)			
16-29	266	18.9	13.9 - 23.9
30-39	583	16.6	13.5 - 19.7
40-49	556	16.5	13.4 - 19.6
50-59	419	16.5	13.6 - 19.4
60+	596	16.2	13.8 - 18.6
Sex[a]			
Male	299	17.5	15.8 - 19.1
Female	1,074	13.7	11.2 - 16.3
Race/Ethnicity[b]			
Minority	160	23.2	13.4 - 33.1
White	2,289	16.3	14.9 - 17.6

[a] $P < .01$, F test
[b] $P < .05$, F test
Source: West et al., 1993

Table 10-68. Distribution of Fish Intake Rates (from all sources and from sport-caught sources) For 1992 Lake Ontario Anglers

Percentile of Lake Ontario Anglers	Fish from All Sources (g/day)	Sport-Caught Fish (g/day)
25%	8.8	0.6
50%	14.1	2.2
75%	23.2	6.6
90%	34.2	13.2
95%	42.3	17.9
99%	56.6	39.8

Source. Connelly et al., 1996.

Table 10-69. Mean Annual Fish Consumption (g/day) for Lake Ontario Anglers, 1992, by Sociodemographic Characteristics

	Mean Consumption	
Demographic Group	Fish from all Sources	Sport-Caught Fish
Overall	17.9	4.9
Residence		
Rural	17.6	5.1
Small City	20.8	6.3
City (25-100,000)	19.8	5.8
City (> 100,000)	13.1	2.2
Income		
< $20,000	20.5	4.9
$21,000-34,000	17.5	4.7
$34,000-50,000	16.5	4.8
>$50,000	20.7	6.1
Age (years)		
<30	13.0	4.1
30-39	16.6	4.3
40-49	18.6	5.1
50+	21.9	6.4
Education		
< High School	17.3	7.1
High School Graduate	17.8	4.7
Some College	18.8	5.5
College Graduate	17.4	4.2
Some Post Grad.	20.5	5.9

Note - Scheffe's test showed statistically significant differences between residence types (for all sources and sport caught) and age groups (all sources).
Source: Connelly et al., 1996.

Table 10-70. Percentile and Mean Intake Rates for Wisconsin Sport Anglers

Percentile	Annual Number of Sport Caught Meals	Intake Rate of Sport-Caught Meals (g/day)
25th	4	1.7
50th	10	4.1
75th	25	10.2
90th	50	20.6
95th	60	24.6
98th	100	41.1
100th	365	150
Mean	18	7.4

Source: Raw data on sport-caught meals from Fiore et al., 1989. EPA calculated intake rates using a value of 150 grams per fish meal; this value is dervied from Pao et al., 1982.

Table 10-71. Sociodemographic Characteristics of Respondents

Category	Subcategory	Percent of Total[a]
Geographic Distribution	Upper Hudson	18 %
	Mid Hudson	35 %
	Lower Hudson	48 %
Age Distribution (years)	< 14	3 %
	15 - 29	26 %
	30 - 44	35 %
	45 - 59	23 %
	> 60	12 %
Annual Household Income	< $10,000	16 %
	$10 - 29,999	41 %
	$30 - 49,999	29 %
	$50 - 69,999	10 %
	$70 - 89,999	2 %
	> $90,000	3 %
Ethnic Background	Caucasian American	67 %
	African American	21 %
	Hispanic American	10 %
	Asian American	1 %
	Native American	1 %

[a] A total of 336 shore-based anglers were interviewed
Source: Hudson River Sloop Clearwater, Inc., 1993

Table 10-72. Number of Grams Per Day of Fish Consumed by All Adult Respondents (Consumers and Non-consumers Combined) - Throughout the Year

Number of Grams/Day	Cumulative Percent	Number of Grams/Day	Cumulative Percent
0.00	8.9%	64.8	80.6%
1.6	9.0%	72.9	81.2%
3.2	10.4%	77.0	81.4%
4.0	10.8%	81.0	83.3%
4.9	10.9%	97.2	89.3%
6.5	12.8%	130	92.2%
7.3	12.9%	146	93.7%
8.1	13.7%	162	94.4%
9.7	14.4%	170	94.8%
12.2	14.9%	194	97.2%
13.0	16.3%	243	97.3%
16.2	22.8%	259	97.4%
19.4	24.0%	292	97.6%
20.2	24.1%	324	98.3%
24.3	27.9%	340	98.7%
29.2	28.1%	389	99.0%
32.4	52.5%	486	99.6%
38.9	52.9%	648	99.7%
40.5	56.5%	778	99.9%
48.6	67.6%	972	100%

N = 500
Weighted Mean = 58.7 grams/day (g/d)
Weighted SE = 3.64
90th Percentile: 97.2 g/d < (90th) < 130 g/d
95th Percentile ≈ 170 g/d
99th Percentile = 389 g/d
Source: CRITFC, 1994

Table 10-73. Fish Intake Throughout the Year by Sex, Age, and Location by All Adult Respondents

	N	Weighted Mean (grams/day)	Weighted SE
Sex			
Female	278	55.8	4.78
Male	222	62.6	5.60
Total	500	58.7	3.64
Age (years)			
18-39	287	57.6	4.87
40-59	155	55.8	4.88
60 & Older	58	74.4	15.3
Total	500	58.7	3.64
Location			
On Reservation	440	60.2	3.98
Off Reservation	60	47.9	8.25
Total	500	58.7	3.64

Source: CRITFC, 1994.

Table 10-74. Children's Fish Consumption Rates - Throughout Year

Number of Grams/Day	Unweighted Cumulative Percent
0.0	21.1%
0.4	21.6%
0.8	22.2%
1.6	24.7%
2.4	25.3%
3.2	28.4%
4.1	32.0%
4.9	33.5%
6.5	35.6%
8.1	47.4%
9.7	48.5%
12.2	51.0%
13.0	51.5%
16.2	72.7%
19.4	73.2%
20.3	74.2%
24.3	76.3%
32.4	87.1%
48.6	91.2%
64.8	94.3%
72.9	96.4%
81.0	97.4%
97.2	98.5%
162.0	100%

N = 194
Unweighted Mean = 19.6 grams/day
Unweighted SE = 1.94

Source: CRITFC, 1994.

Table 10-75. Sociodemographic Factors and Recent Fish Consumption

	Peak Consumption[a]		Recent Consumption[b]			
	Average[c]	≥3[d] (%)	Walleye	N. Pike	Muskellunge	Bass
All participants (N-323)	1.7	20	4.2	0.3	0.3	0.5
Gender						
Male (n-148)	1.9	26	5.1	0.5[a]	0.5	0.7[a]
Female (n-175)	1.5	15	3.4	0.2	0.1	0.3
Age (y)						
<35 (n-150)	1.8	23	5.3[a]	0.3	0.2	0.7
≥35 (n-173)	1.6	17	3.2	0.4	0.3	0.3
High School Graduate						
No (n-105)	1.6	18	3.6	0.2	0.4	0.7
Yes (n-218)	1.7	21	4.4	0.4	0.2	0.4
Unemployed						
Yes (n-78)	1.9	27	4.8	0.6	0.6	1.1
No (n-245)	1.6	18	4.0	0.3	0.2	0.3

[a] Highest number of fish meals consumed/week.
[b] Number of meals of each species in the previous 2 months.
[c] Average peak fish consumption.
[d] Percentage of population reporting peak fish consumption of ≥3 fish meals/week.
Source: Peterson et al., 1994.

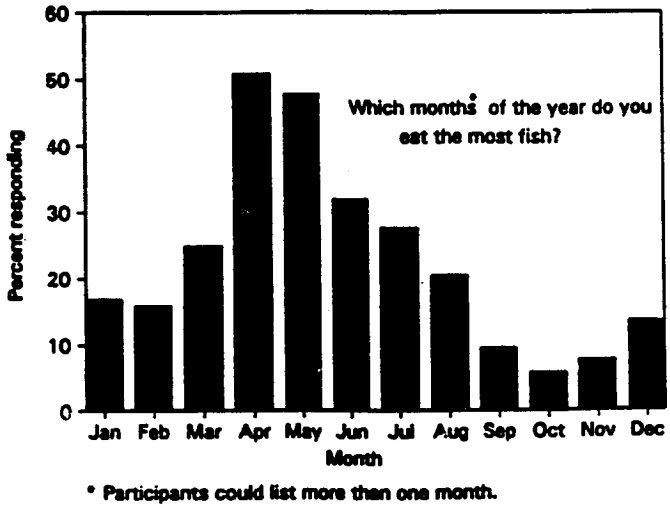

Figure 10-1. Sesonal Fish Consumption: Wisconsin Chippewa, 1990

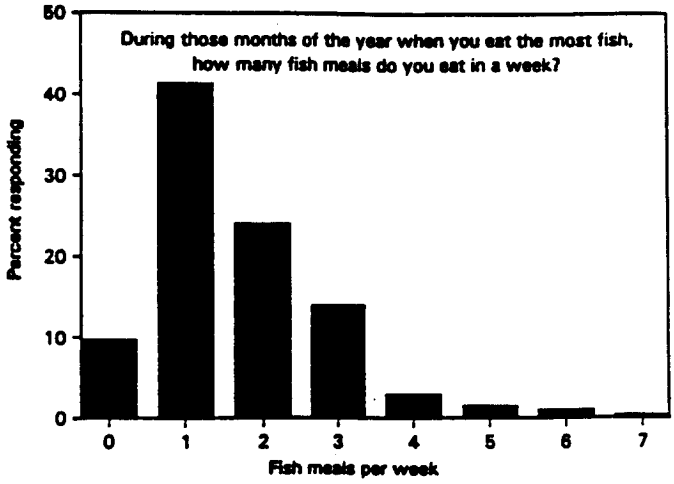

Figure 10-2. Peak Fish Consumption: Wisconsin Chippewa, 1990.

Source: Peterson et al., 1994.

Table 10-76. Number of Local Fish Meals Consumed Per Year by Time Period for All Respondents

Number of Local Fish Meals Consumed Per Year	Time Period											
	During Pregnancy				≤1 Yr. Before Pregnancy[a]				>Yr. Before Pregnancy[b]			
	Mohawk		Control		Mohawk		Control		Mohawk		Control	
	N[c]	%	N[c]	%	N[c]	%	N[c]	%	N[c]	%	N[c]	%
None	63	64.9	109	70.8	42	43.3	99	64.3	20	20.6	93	60.4
1 - 9	24	24.7	24	15.6	40	41.2	31	20.1	42	43.3	35	22.7
10 - 19	5	5.2	7	4.5	4	4.1	6	3.9	6	6.2	8	5.2
20 - 29	1	1.0	5	3.3	3	3.1	3	1.9	9	9.3	5	3.3
30 - 39	0	0.0	2	1.3	0	0.0	3	1.9	1	1.0	1	0.6
40 - 49	0	0.0	1	0.6	1	1.0	1	0.6	1	1.0	1	0.6
50+	4	4.1	6	3.9	7	7.2	11	7.1	18	18.6	11	7.1
Total	97	100.0	154	100.0	97	100.0	154	100.0	97	100.0	154	100.0

[a] p <0.05 for Mohawk vs. Control.
[b] p <0.001 for Mohawk vs. Control.
[c] N = number of respondents.
Source: Fitzgerald et al., 1995.

Table 10-77. Mean Number of Local Fish Meals Consumed Per Year by Time Period for All Respondents and Consumers Only

	All Respondents (N=97 Mohawks and 154 Controls)			Consumers Only (N=82 Mohawks and 72 Controls)		
	During Pregnancy	≤1 Yr. Before Pregnancy	>1 Yr. Before Pregnancy	During Pregnancy	≤1 Yr. Before Pregnancy	>1 Yr. Before Pregnancy
Mohawk	3.9 (1.2)	9.2 (2.3)	23.4 (4.3)[a]	4.6 (1.3)	10.9 (2.7)	27.6 (4.9)
Control	7.3 (2.1)	10.7 (2.6)	10.9 (2.7)	15.5 (4.2)[a]	23.0 (5.1)[b]	23.0 (5.5)

[a] p <0.001 for Mohawk vs. Control.
[b] p<0.05 for Mohawk vs. Control
( ) = standard error.
Test for linear trend:
p<0.001 for Mohawk (All participants and consumers only);
p=0.07 for Controls (All participants and consumers only).
Source: Fitzgerald et al., 1995.

Table 10-78. Mean Number of Local Fish Meals Consumed Per Year by Time Period and Selected Characteristics for All Respondents (Mohawk, N=97; Control, N=154)

	Time Period					
	During Pregnancy		≤1 Year Before Pregnancy		>1 Year Before Pregnancy	
Background Variable	Mohawk	Control	Mohawk	Control	Mohawk	Control
Age (Yrs)						
<20	7.7	0.8	13.5	13.9	27.4	10.4
20 - 24	1.3	5.9	5.7	14.5	20.4	15.9
25 - 29	3.9	9.9	15.5	6.2	25.1	5.4
30 - 34	12.0	7.6	9.5	2.9	12.0	5.6
>34	1.8	11.2	1.8	26.2	52.3	22.1[a]
Education (Yrs)						
<12	6.3	7.9	14.8	12.4	24.7	8.6
12	7.3	5.4	8.1	8.4	15.3	11.4
13 - 15	1.7	10.1	8.0	15.4	29.2	13.3
>15	0.9	6.8	10.7	0.8	18.7	2.1
Cigarette Smoking						
Yes	3.8	8.8	10.4	13.0	31.6	10.9
No	3.9	6.4	8.4	8.3	18.1	10.8
Alcohol Consumption						
Yes	4.2	9.9	6.8	13.8	18.0	14.8
No	3.8	6.3[b]	12.1	4.7[c]	29.8	2.9[d]

[a] F (4,149) = 2.66, p=0.035 for Age Among Controls.
[b] F (1,152) = 3.77, p=0.054 for Alcohol Among Controls.
[c] F (1,152) = 5.20, p=0.024 for Alcohol Among Controls.
[d] F (1,152) = 6.42, p=0.012 for Alcohol Among Controls.
Source: Fitzgerald et al., 1995.

Table 10-79. Percentage of Individuals Using Various Cooking Methods at Specified Frequencies

Study	Use Frequency	Bake	Pan Fry	Deep Fry	Broil or Grill	Poach	Boil	Smoke	Raw	Other
Connelly et al., 1992	Always	24(a)	51	13		24(a)				
	Ever	75(a)	88	59		75(a)				
Connelly et al., 1996	Always	13	4	4						
	Ever	84	72	42						
CRITFC, 1994	At least monthly	79	51	14	27	11	46	31	1	34(b) 29(c) 49(d)
	Ever	98	80	25	39	17	73	66	3	67(b) 71(c) 75(d)
Fitzgerald et al., 1995	Not Specified		94(e)(f)	71(e)(g)						
Puffer et al., 1981	As Primary Method	16.3	52.5	12					0.25	19(h)

[a] 24 and 75 listed as bake, BBQ, or poach
[b] Dried
[c] Roasted
[d] Canned
[e] Not specified whether deep or pan fried
[f] Mohawk women
[g] Control population
[h] boil, stew, soup, or steam

Table 10-80. Percent Moisture and Fat Content for Selected Species[a]

Species	Moisture Content (%)	Total Fat Content (%)[b]	Comments
		FINFISH	
Anchovy, European	73.37	4.101	Raw
	50.30	8.535	Canned in oil, drained solids
Bass	75.66	3.273	Freshwater, mixed species, raw
Bass, Striped	79.22	1.951	Raw
Bluefish	70.86	3.768	Raw
Butterfish	74.13	NA	Raw
Carp	76.31	4.842	Raw
	69.63	6.208	Cooked, dry heat
Catfish	76.39	3.597	Channel, raw
	58.81	12.224	Channel, cooked, breaded and fried
Cod, Atlantic	81.22	0.456	Atlantic, raw
	75.61	0.582	Canned, solids and liquids
	75.92	0.584	Cooked, dry heat
	16.14	1.608	Dried and salted
Cod, Pacific	81.28	0.407	Raw
Croaker, Atlantic	78.03	2.701	Raw
	59.76	11.713	Cooked, breaded and fried
Dolphinfish, Mahimahi	77.55	0.474	Raw
Drum, Freshwater	77.33	4.463	Raw
Flatfish, Flounder and Sole	79.06	0.845	Raw
	73.16	1.084	Cooked, dry heat
Grouper	79.22	0.756	Raw, mixed species
	73.36	0.970	Cooked, dry heat
Haddock	79.92	0.489	Raw
	74.25	0.627	Cooked, dry heat
	71.48	0.651	Smoked
Halibut, Atlantic & Pacific	77.92	1.812	Raw
	71.69	2.324	Cooked, dry heat
Halibut, Greenland	70.27	12.164	Raw
Herring, Atlantic & Turbot, domestic species	72.05	7.909	Raw
	64.16	10.140	Cooked, dry heat
	59.70	10.822	Kippered
	55.22	16.007	Pickled
Herring, Pacific	71.52	12.552	Raw
Mackerel, Atlantic	63.55	9.076	Raw
	53.27	15.482	Cooked, dry heat
Mackerel, Jack	69.17	4.587	Canned, drained solids
Mackerel, King	75.85	1.587	Raw
Mackerel, Pacific & Jack	70.15	6.816	Canned, drained solids
Mackerel, Spanish	71.67	5.097	Raw
	68.46	5.745	Cooked, dry heat
Monkfish	83.24	NA	Raw
Mullet, Striped	77.01	2.909	Raw
	70.52	3.730	Cooked, dry heat
Ocean Perch, Atlantic	78.70	1.296	Raw
	72.69	1.661	Cooked, dry heat
Perch, Mixed species	79.13	0.705	Raw
	73.25	0.904	Cooked, dry heat
Pike, Northern	78.92	0.477	Raw
	72.97	0.611	Cooked, dry heat
Pike, Walleye	79.31	0.990	Raw

Table 10-80. Percent Moisture and Fat Content for Selected Species[a] (continued)

Species	Moisture Content (%)	Total Fat Content (%)[b]	Comments
Pollock, Alaska & Walleye	81.56	0.701	Raw
	74.06	0.929	Cooked, dry heat
Pollock, Atlantic	78.18	0.730	Raw
Rockfish, Pacific, mixed species	79.26	1.182	Raw (Mixed species)
	73.41	1.515	Cooked, dry heat (mixed species)
Roughy, Orange	75.90	3.630	Raw
Salmon, Atlantic	68.50	5.625	Raw
Salmon, Chinook	73.17	9.061	Raw
	72.00	3.947	Smoked
Salmon, Chum	75.38	3.279	Raw
	70.77	4.922	Canned, drained solids with bone
Salmon, Coho	72.63	4.908	Raw
	65.35	6.213	Cooked, moist heat
Salmon, Pink	76.35	2.845	Raw
	68.81	5.391	Canned, solids with bone and liquid
Salmon, Red & Sockeye	70.24	4.560	Raw
	68.72	6.697	Canned, drained solids with bone
	61.84	9.616	Cooked, dry heat
Sardine, Atlantic	59.61	10.545	Canned in oil, drained solids with bone
Sardine, Pacific	68.30	11.054	Canned in tomato sauce, drained solids with bone
Sea Bass, mixed species	78.27	1.678	Cooked, dry heat
	72.14	2.152	Raw
Seatrout, mixed species	78.09	2.618	Raw
Shad, American	68.19	NA	Raw
Shark, mixed species	73.58	3.941	Raw
	60.09	12.841	Cooked, batter-dipped and fried
Snapper, mixed species	76.87	0.995	Raw
	70.35	1.275	Cooked, dry heat
Sole, Spot	75.95	3.870	Raw
Sturgeon, mixed species	76.55	3.544	Raw
	69.94	4.544	Cooked, dry heat
	62.50	3.829	Smoked
Sucker, white	79.71	1.965	Raw
Sunfish, Pumpkinseed	79.50	0.502	Raw
Swordfish	75.62	3.564	Raw
	68.75	4.569	Cooked, dry heat
Trout, mixed species	71.42	5.901	Raw
Trout, Rainbow	71.48	2.883	Raw
	63.43	3.696	Cooked, dry heat
Tuna, light meat	59.83	7.368	Canned in oil, drained solids
	74.51	0.730	Canned in water, drained solids
Tuna, white meat	64.02	NA	Canned in oil
	69.48	2.220	Canned in water, drained solids
Tuna, Bluefish, fresh	68.09	4.296	Raw
	59.09	5.509	Cooked, dry heat
Turbot, European	76.95	NA	Raw
Whitefish, mixed species	72.77	5.051	Raw
	70.83	0.799	Smoked
Whiting, mixed species	80.27	0.948	Raw
	74.71	1.216	Cooked, dry heat
Yellowtail, mixed species	74.52	NA	Raw

Table 10-80. Percent Moisture and Fat Content for Selected Species[a] (continued)

Species	Moisture Content (%)	Total Fat Content (%)[b]	Comments
SHELLFISH			
Crab, Alaska King	79.57	NA	Raw
	77.55	0.854	Cooked, moist heat
			Imitation, made from surimi
Crab, Blue	79.02	0.801	Raw
	79.16	0.910	Canned (dry pack or drained solids of wet pack)
	77.43	1.188	Cooked, moist heat
	71.00	6.571	Crab cakes
Crab, Dungeness	79.18	0.616	Raw
Crab, Queen	80.58	0.821	Raw
Crayfish, mixed species	80.79	0.732	Raw
	75.37	0.939	Cooked, moist heat
Lobster, Northern	76.76	NA	Raw
	76.03	0.358	Cooked, moist heat
Shrimp, mixed species	75.86	1.250	Raw
	72.56	1.421	Canned (dry pack or drained solids of wet pack)
	52.86	10.984	Cooked, breaded and fried
	77.28	0.926	Cooked, moist heat
Spiny Lobster, mixed species	74.07	1.102	Imitation made from surimi, raw
Clam, mixed species	81.82	0.456	Raw
	63.64	0.912	Canned, drained solids
	97.70	NA	Canned, liquid
	61.55	10.098	Cooked, breaded and fried
	63.64	0.912	Cooked, moist heat
Mussel, Blue	80.58	1.538	Raw
	61.15	3.076	Cooked, moist heat
Octopus, common	80.25	0.628	Raw
Oyster, Eastern	85.14	1.620	Raw
	85.14	1.620	Canned (solids and liquid based) raw
	64.72	11.212	Cooked, breaded and fried
	70.28	3.240	Cooked, moist heat
Oyster, Pacific	82.06	1.752	Raw
Scallop, mixed species	78.57	0.377	Raw
	58.44	10.023	Cooked, breaded and fried
	73.82	NA	Imitation, made from Surimi
Squid	78.55	0.989	Raw
	64.54	6.763	Cooked, fried

[a] Data are reported as in the Handbook

[b] Total Fat Content - saturated, monosaturated and polyunsaturated

NA = Not available

Source: USDA, 1979-1984 - U.S. Agricultural Handbook No. 8

Table 10-81. Recommendations - General Population		
Mean Intake (g/day)	95th Percentile of Long-term Intake Distribution (g/day)	Study (Reference)
	63 (Value of 42 from Javitz was adjusted upward by 50 percent to account for recent increase in fish consumption)	TRI (Javitz, 1980; Ruffle et al., 1994)
20.1 (Total Fish) 14.1 (Marine Fish) 6.0 (Freshwater/Estuarine Fish)		U.S. EPA Analysis of CSFII, 1989-91

Table 10-82. Recommendations - General Population - Fish Serving Size		
Mean Intake (grams)	95th Percentile (grams)	Study (Reference)
129	326	1989-1991 CSFII (U.S. EPA, 1996)

Table 10-83. Recommendations - Recreational Marine Anglers			
Mean Intake (g/day)	95th Percentile (g/day)	Study Location	Study
5.6	18.0	Atlantic	NMFS, 1993
7.2	26.0	Gulf	
2.0	6.8	Pacific	

Table 10-84. Recommendations - Freshwater Anglers			
Mean Intake (g/day)	Upper Percentile (g/day)	Study Location	Reference
5	13 (95th percentile)	Maine	Ebert et al., 1992
5	18 (95th percentile)	New York	Connelly et al., 1996
12	39 (96th percentile)	Michigan	West et al, 1989
17	---	Michigan	West et al, 1993

Table 10-85. Recommendations - Native American Subsistence Populations

Per-Capita (or Mean) Intake (g/day)	Upper Percentile (g/day)	Study Population	Reference
59	170 (95th)	4 Columbia River Tribes	CRITFC, 1994
16	---	94 Alaska Communities (Lowest of 94)	Wolfe and Walker, 1989
81	---	94 Alaska Communities (Median of 94)	Wolfe and Walker, 1989
770	---	94 Alaska Communities (Highest of 94)	Wolfe and Walker, 1989

Table 10-86. Summary of Fish Intake Studies

Source of Data (Reference)	Population Surveyed	Survey Time Period/Type	Analyses Performed (References)	Limitations/Advantages
General Population				
Key Studies				
Javitz, 1980 - TRI Survey	25,162 individuals - general population; the TRI Survey sample	Sept. 1973-Aug. 1974 (1 year survey). Completed diary over 1 month period on date of meal consumption, species of fish, packaging type, amount of fish prepared, number of servings consumed, etc.	Mean and distribution of fish consumption rates grouped by race, age, gender, census region, fish species, community type, and religion. Lognormal distribution fit to fish intake distribution by age and region by Ruffle et al. (1994).	High response rate (80%); population was large and geographically and seasonally representative; consumption rates based on one month of diary data; survey data is over 20 years out of date
U.S. EPA, 1996a	11,912 individuals - general population	Participants provided 3 consecutive days of dietary data. Three survey years (1989-1991) combined into one data set.	Analysis of CSFII 1989-91. Fish grouped by habitat (freshwater vs. marine) and type (finfish vs. shellfish). Per capita fish intake rates calculated using cooked and uncooked equivalent weight and reported in g/day and g/kg-day; also intake distribution per day eating fish.	Large, geographically representative study; relatively recent. Based on short-term (3 day) data so long-term percentiles of fish intake distribution could not be estimated.
Relevant Studies				
AIHC, 1994	--	--	Distributions using @Risk simulation software.	Limited reviews of supporting studies; good alternative source of information.
Pao et al., 1982	37,874 individuals - general population	Participants provided 3 consecutive days of dietary data. Survey conducted between April 1977 and March 1978.	Mean and distribution of average daily fish intake and average fish intake per eating occasion; by age-sex groups and overall.	Population was large and geographically representative; data were based on short-term dietary recall; data are almost 20 years out of date.
Tsang and Klepeis, 1996	9,386 individuals - general population	Participants provided 24-hour diary data. Follow-up questionnaires, survey conducted between October 1992 and September 1994.	Frequency of eating fish and number of servings per month provided.	Population large and geographically and seasonally balanced; data based on recall; intake data not provided.
USDA, 1992	10,000 individuals-general population	Participants provided 3 consecutive days of dietary data. Survey conducted between April 1987 and March 1988.	Per capita fish intake rates and percent of population consuming fish in one day; by age and sex.	Population was large and geographically and seasonally balanced; data based on short-term dietary recall.

Table 10-86. Summary of Fish Intake Studies (continued)

Source of Data (Reference)	Population Surveyed	Survey Time Period/Type	Analyses Performed (References)	Limitations/Advantages
Recreational-Marine Fish **Key Study**				
NMFS 1986a, b, c; 1993	Atlantic and Gulf Coasts - 41,000 field interviews and 58,000 telephone interviews; Pacific Coast - 38,000 field interviews and 73,000 telephone interviews.	Telephone interviews with residents of coastal counties; information on fishing frequency and mode of fishing trips. Field interviews with marine anglers; information on area and mode fished, fishing frequency, species caught, weight of fish, and whether fish were intended to be consumed.	Intake rates were not calculated; total catch size grouped by marine species, seasons, and number of fishermen for each coastal region were presented.	Population was large geographically and seasonally balanced; fish caught were weighed in the field. No information on number of potential consumers of catch.
Relevant Studies				
Pierce et al., 1981	~500 anglers in Commencement Bay, Washington	July-November 1980; creel survey interviews conducted consisting of 5 summer days and 4 fall days.	Distribution of fishing frequency; total weight of catch grouped by species. Re-analysis by Price et al. (1994) using inverse fishing frequency as sample weights.	Local survey. Original analysis by Pierce et al. (1981) did not calculate intake rates; analysis over-estimated fishing frequency distribution by oversampling frequent anglers. Re-analysis by Price et. al. (1994) involved several assumptions; thus results are questionable.
Puffer et al., 1981	1,067 anglers in the Los Angeles, California area.	Creel survey conducted for the full 1980 calendar year.	Distribution of sport fish intake rates. Median rates by age, ethnicity and fish species. Re-analysis by Price et al. (1994) using inverse fishing frequency as sample weights.	Local survey. Original (unweighted) analysis over-estimated fish intake by oversampling frequent anglers. Re-analysis by Price et al. (1994) involves several assumptions; thus results are questionable.
U.S. DHHS, 1995	330 everglade residents/ subsistence fishermen or both	1992-1993; questionnaire with demographic information and fishing and eating habits.	Provides data for fishing frequency by sex, age, and ethnicity.	Intake rates were not reported, study not representative of the U.S. population; one of few studies that target subsistence fishermen.

Table 10-86. Summary of Fish Intake Studies (continued)

Source of Data (Reference)	Population Surveyed	Survey Time Period/Type	Analyses Performed (References)	Limitations/Advantages
Recreational Fresh Water Fish				
Key Studies				
Chemrisk, 1991; Ebert et al., 1993	1,612 licensed Maine anglers	1989-1990 ice fishing season and 1990 open water season; mailed survey; one year recall of frequency of fishing trips, number and length of fish species caught.	Mean and distribution of fish consumption rates by ethnic groups and overall. Mean and distribution of fish consumption rates for fish from rivers and streams. EPA analysis of fish intake for household members.	Data based on one year recall; high response rate; area-specific consumption patterns.
Connelly et al., 1996	825 anglers with NY State fishing licenses intending to fish Lake Ontario.	Survey consisted of self-recording information in a diary for 1992 fishing trips and fish consumption.	Distribution of intake rates of sport caught fish.	Meal size estimated by comparison with pictures of 8 oz. fish meals.
West et al., 1993	2,681 persons with Michigan fishing licenses	January 1991 through January 1992; mailed survey; 7-day recall; demographics information requested, and quantity of fish eaten, if any, at each meal based on a photograph of 1/2 lb of fish (more about same, or less).	Mean consumption rate for sport and total fish by demographic category (West et al., 1993) and 50th, 90th, and 95th percentile (U.S. EPA, 1995).	Relatively low response made and only three categories were used to assign fish portion size. Relatively large-scale study and reliance on short-term recall.
West et al., 1989	1,171 Michigan residents with fishing licenses	January-May 1988; anglers completed questionnaires based on 7-day and 1-year recall.	Mean intake rates of self-caught fish based on 7-day recall period and mean and percentiles of self-caught fish intake based on one year recall.	Weight of fish consumed was estimated using a picture of an 8 oz. fish meal; smaller meals were judged to be 5 oz., larger ones 10 oz.
Relevant Studies				
Connelly et al., 1992	1,030 anglers licensed in New York	Survey mailed out in Jan. 1992; one year recall of the period Oct. 1990-Sept. 1991	Knowledge and effects of fish health advisories. Mean number of sport-caught fish meals.	Response rate of 52.8%; only number of fish mealsreported.
Fiore et al., 1989	801 individuals with Wisconsin fish or sporting licenses	1985 summer; mailed survey; one year recall of sport fish consumption.	Mean number of sport caught fish meals of Wisconsin anglers.	Constant meal size assumed.
Hudson River Sloop Clearwater, Inc. (1993)	336 shore-based anglers	Survey conducted June-November 1991; April-July 1992. Onsite interview with anglers	Knowledge and adherance to health advsisories	Data collected from personal interviews; intake data not provided; fish meal data provided.

Table 10-86. Summary of Fish Intake Studies (continued)				
Source of Data (Reference)	Population Surveyed	Survey Time Period/Type	Analyses Performed (References)	Limitations/Advantages
Native American				
<u>Key Studies</u>				
CRITFC, 1994	Four tribes in Washington state; total of 513 adults and 204 children under five	Fall and Winter of 1991-1992; stratified random sampling approach; in-person interviews; information requested included 24-hour dietary recall, seasonal and annual number of fish meals, average weight of fish meals and species consumed.	Mean and distribution of fish intake rates for adults and for children. Mean intake rates by age and gender. Frequency of cooking and preparation methods.	Survey was done at only one time of the year and involved one year recall; fish intake rates were based on all fish sources but great majority was locally caught; study provides consumption and habits for subsistence subpopulation group.
Fitzgerald et al. 1995	97 Mohawk women in New York; 154 Caucasian women; nursing mothers	1988-1992, up to 3-year recall	Mean number of sport-caught fish meals per year.	Survey for nursing mothers only, recall for up to 3 years; small sample size; may be representative of Mohawk women; measured in fish meals.
Petersen et al., 1994	327 residents of Chippewa reservation, Wisconsin	Self-administered questionaire completed in May, 1990.	Mean number of fish meals per year.	Did not distinguish between commercial and sport-caught meals.
Wolfe and Walker, 1987	Ninety-eight communities in Alaska surveyed by various researchers	Surveys conducted between 1980 and 1985; data based on 1-year recall period. Annual per capita harvest of fish, land mammals, marine mammals and other resources estimated for each community.	Distribution among communities of annual per-capita harvests for each resource category.	Data based on 1-year recall; data provided are harvest data that must be converted to individual intake rates; surveyed communities are only a sample of all Alaska communities.

[a] NFMS - National Marine Fisheries Services.

Table 10-87. Confidence in Fish Intake Recommendations for General Population

Considerations	Rationale	Rating
Study Elements		
• Level of peer review	Peer reviewed by USDA and EPA.	High
• Accessibility	CSFII data are publicly available. Javitz is a contractor report to EPA.	High (CSFII) Medium (Javitz)
• Reproducibility	Enough information is available to reproduce results.	High
• Focus on factor of interest	The studies focused on fish ingestion.	High
• Data pertinent to U.S.	The studies were conducted for U.S. population.	High
• Primary data	The studies are primary studies.	High
• Currency	Studies were conducted from 1973-1974 to 1989-1991.	Medium (mean) Low (Long-Term Distribution)
• Adequacy of data collection period	Long-term distribution are based on one month data collection period.	High (Mean) Medium (Long-term distribution)
• Validity of approach	Data are collected using diaries and one-day recall. However, data adjusted to account for changes in eating pattern.	Medium
• Study size	The Range of samples was 10,000 -37,000.	High
• Representativeness of the population	The data are representative of overall U.S. population.	High
• Characterization of variability	Long-term distribution (generated from 1973-1974 data) was shifted upward based on recent increase in mean consumption.	Medium
• Lack of bias in study design (high rating is desirable)	Response rates were fairly high; there was no obvious source of bias.	High
• Measurement error	Estimates of intake amounts were imprecise.	Medium
Other Elements		
• Number of studies	There was 1 study for the mean, the results of 2 studies were utilized for long-term distribution.	Low
• Agreement between researchers		Medium
Overall Rating		Medium (Mean) Low (Long-term distribution)

Table 10-88. Confidence in Fish Intake Recommendations for Recreational Marine Anglers

Considerations	Rationale	Rating
Study Elements		
• Level of peer review	Data were reviewed by NMFS and EPA.	High
• Accessibility	The analysis of the NMFS data is presented in the Handbook and NMFS data can be found in NMFS publications.	High
• Reproducibility	Enough information is available to reproduce results.	High
• Focus on factor of interest	Studies focused on fish catch rather than fish consumption per se.	Medium
• Data pertinent to U.S.	The studies were conducted in the U.S.	High
• Primary data	Data are from primary studies.	High
• Currency	The data were based on 1993 studies.	High
• Adequacy of data collection period	Data were collected once for each angler. The yearly catch of anglers were estimated from catch on intercepted trip and reported fishing frequency.	Medium
• Validity of approach	The creel survey provided data on fishing frequency and fish weight; telephone survey data provided number of anglers. An average value was used for the number of intended fish consumers and edible fraction.	Medium
• Study size	Studies encompassed a population of over 100,000.	High
• Representativeness of the population	Data were representative of overall U.S. coastal state population.	High
• Characterization of variability	Distributions were generated.	High
• Lack of bias in study design (high rating is desirable)	Response rates were fairly high; There was no obvious source of bias.	High
• Measurement error	Fish were weighed in the field.	High
Other Elements		
• Number of studies	There was 1 study.	Low
• Agreement between researchers	N/A	
Overall Rating		Medium

Table 10-89. Confidence in Recommendations for Fish Consumption - Recreational Freshwater

Considerations	Rationale	Rating
Study Elements		
• Level of peer review	Studies can be found in peer reviewed journals and has been reviewed by the EPA.	High
• Accessibility	The original study analyses are reported in accessible journals. Subsequent EPA analyses are detailed in Handbook.	High
• Reproducibility	Enough information is available to reproduce results.	High
• Focus on factor of interest	Studies focused on ingestion of fish by the recreational freshwater angler.	High
• Data pertinent to U.S.	The studies were conducted in the U.S.	High
• Primary data	Data are from primary references.	High
• Currency	Studies were conducted between 1988-1992.	High
• Adequacy of data collection period	Data were collected for one year period for 3 studies; and a one week period for one study.	High
• Validity of approach	Data presented are as follows: one year recall of fishing trips (2 studies), one week recall of fish consumption (1 study), and one year diary survey (1 study). Weight of fish consumed was estimated using approximate weight of fish catch and edible fraction or approximate weight of fish meal.	Medium
• Study size	Study population ranged from 800-2600.	High
• Representativeness of the population	Each study was localized to a single state or area.	Low
• Characterization of variability	Distributions were generated.	High
• Lack of bias in study design (high rating is desirable)	Response rates were fairly high. One year recall of fishing trips may result in overestimate.	Medium
• Measurement error	Weight of fish portions were estimated in one study, fish weight was estimated from reported fish length in another study.	Medium
Other Elements		
• Number of studies	There are 4 key studies.	High
• Agreement between researchers	Intake rates in different parts of country may be expected to show some variation.	Medium
Overall Rating	The main drawback is that studies are not nationally representative and not representative of long-term consumption.	Medium

Table 10-90. Confidence in Recommendations for Native American Subsistence Fish Consumption

Considerations	Rationale	Rating
Study Elements		
• Level of peer review	Studies are from peer reviewed journal (1 study), and technical reports (1study).	Medium
• Accessibility	Journal articles are publicly available. CRITFC is a technical report.	Medium
• Reproducibility	The studies were adequately detailed.	High
• Focus on factor of interest	Studies focused on fish ingestion and fish harvest.	High
• Data pertinent to U.S.	All studies were specific to area in the U.S.	High
• Primary data	One study used primary data, the other used secondary data.	Medium
• Currency	Data were from early 1980's to 1992.	Medium
• Adequacy of data collection period	Data collected for one year period.	High
• Validity of approach	One study used fish harvest data; EPA used a factor to convert to individual intake. Other study measured individual intake directly.	Medium
• Study size	The sample population was 500 for the study with primary data.	Medium
• Representativeness of the population	Only two states were represented.	Low
• Characterization of variability	Individual variation were not described in summary study.	Medium
• Lack of bias in study design (high rating is desirable)	The response rate was 69% in study with primary data. Bias was hard to evaluate in summary study.	Medium
• Measurement error	The weight of the fish was estimated.	Medium
Other Elements		
• Number of studies	There were two studies; only one study described individual variation in intake.	Medium
• Agreement between researchers	Range of per-capita rates from summary study includes per-capita rate from study with primary data.	High
Overall Rating	Studies are not nationally representative. Upper percentiles are based on only one study.	Medium (per capita intake) Low (upper percentiles)

APPENDIX 10A

RESOURCE UTILIZATION DISTRIBUTION

Appendix 10A. Resource Utilization Distribution

The percentiles of the resource utilization distribution of Y are to be distinguished from the percentiles of the (standard) distribution of Y. The latter percentiles show what percentage of individuals in the population are consuming below a given level. Thus, the 50th percentile of the distribution of Y is that level such that 50 percent of individuals consume below it; on the other hand, the 50th percentile of the resource utilization distribution is that level such that 50 percent of the overall consumption in the population is done by individuals consuming below it.

The percentiles of the resource utilization distribution of Y will always be greater than or equal to the corresponding percentiles of the (standard) distribution of Y, and, in the case of recreational fish consumption, usually considerably exceed the standard percentiles.

To generate the resource utilization distribution, one simply weights each observation in the data set by the Y level for that observation and performs a standard percentile analysis of weighted data. If the data already have weights, then one multiplies the original weights by the Y level for that observation, and then performs the percentile analysis.

Under certain assumptions, the resource utilization percentiles of fish consumption may be related (approximately) to the (standard) percentiles of fish consumption derived from the analysis of creel studies. In this instance, it is assumed that the creel survey data analysis did not employ sampling weights (i.e., weights were implicitly set to one); this is the case for many of the published analyses of creel survey data. In creel studies the fish consumption rate for the ith individual is usually derived by multiplying the amount of fish consumption per fishing trip (say C_i) by the frequency of fishing (say f_i). If it is assumed that the probability of sampling of an angler is proportional to fishing frequency, then sampling weights of inverse fishing frequency ($1/ f_i$) should be employed in the analysis of the survey data. Above it was stated that for data that are already weighted the resource utilization distribution is generated by multiplying the original weights by the individual's fish consumption level to create new weights. Thus, to generate the resource utilization distribution from the data with weights of ($1/ f_i$), one multiplies ($1/ f_i$) by the fish consumption level of $f_i C_i$ to get new weights of C_i.

Now if C_i (amount of consumption per fishing trip) is constant over the population, then these new weights are constant and can be taken to be one. But weights of one is what (it is assumed) were used in the original creel survey data analysis. Hence, the resource utilization distribution is exactly the same as the original (standard) distribution derived from the creel survey using constant weights.

The accuracy of this approximation of the resource utilization distribution of fish by the (standard) distribution of fish consumption derived from an unweighted analysis of creel survey data depends then on two factors, how approximately constant the C_i 's are in the population and how approximately proportional the relationship between sampling probability and fishing frequency is. Sampling probability will be roughly proportional to frequency if repeated sampling at the same site is limited or if re-interviewing is performed independent of past interviewing status.

Note: For any quantity Y that is consumed by individuals in a population, the percentiles of the "resource utilization distribution" of Y can be formally defined as follows: Y_p (R) is the pth percentile of the resource utilization distribution if p percent of the overall consumption of Y in the population is done by individuals with consumption below Y_p (R) and 100-p percent is done by individuals with consumption above Y_p(R).

APPENDIX 10B

FISH PREPARATION AND COOKING METHODS

Table 10B-1. Percent of Fish Meals Prepared Using Various Cooking Methods by Residence Size[a]

Residence Size	Large City/Suburb	Small City	Town	Small Town	Rural Non-Farm	Farm
			Total Fish			
Cooking Method						
Pan Fried	32.7	31.0	36.0	32.4	38.6	51.6
Deep Fried	19.6	24.0	23.3	24.7	26.2	15.7
Boiled	6.0	3.0	3.4	3.7	3.4	3.5
Grilled/Broiled	23.6	20.8	13.8	21.4	13.7	13.1
Baked	12.4	12.4	10.0	10.3	12.7	6.4
Combination	2.5	6.0	8.3	5.0	2.3	7.0
Other (Smoked, etc.)	3.2	2.8	5.2	1.9	2.9	1.8
Don't Know	0.0000	0.0000	0.0000	0.5	0.2	--
Total (N)[b]	393	317	388	256	483	94
			Sport Fish			
Pan Fried	45.8	45.7	47.6	41.4	51.2	63.3
Deep Fried	12.2	14.5	17.5	15.2	21.9	7.3
Boiled	2.8	2.3	2.9	0.5	3.6	0
Grilled/Broiled	20.2	17.6	10.6	25.3	8.2	10.4
Baked	11.8	8.8	6.3	8.7	9.7	6.9
Combination	2.7	8.5	10.4	6.7	1.9	9.3
Other (smoked, etc.)	4.5	2.7	4.9	1.5	3.5	2.8
Don't Know	0	0	0	0.7	0	0
Total (N)	205	171	257	176	314	62

[a] Large City = over 100,000; Small City = 20,000-100,000; Town = 2,000-20,000; Small Town = 100-2,000.
[b] N = Total number of respondents
Source: West et al., 1993.

Table 10B-2. Percent of Fish Meals Prepared Using Various Cooking Methods by Age

Age (years)	17-30	31-40	41-50	51-64	>64	Overall
			Total Fish			
Cooking Method						
Pan Fried	45.9	31.7	30.5	33.9	40.7	35.3
Deep Fried	23.0	24.7	26.9	23.7	14.0	23.5
Boiled	0.0000	6.0	3.6	3.9	4.3	3.9
Grilled or Boiled	15.6	15.2	24.3	16.1	18.8	17.8
Baked	10.8	13.0	8.7	12.8	11.5	11.4
Combination	3.1	5.2	2.2	6.5	6.8	4.7
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0	3.2
Don't Know	0.0000	0.0000	0.3	0.4	0.0000	0.2
Total (N)[a]	246	448	417	502	287	1946
			Sport Fish			
Pan Fried	57.6	42.6	43.4	46.6	54.1	47.9
Deep Fried	18.2	21.0	17.3	14.8	7.7	16.5
Boiled	0.0000	4.4	0.8	3.2	3.1	2.4
Grilled/Broiled	15.0	10.1	25.9	12.2	12.2	14.8
Baked	3.6	10.4	6.4	11.7	9.9	8.9
Combination	3.8	7.2	3.0	7.5	8.2	5.9
Other (Smoked, etc.)	1.7	4.3	3.2	3.5	4.8	3.5
Don't Know	0.0000	0.0000	0.0000	0.4	0.0000	0.1
Total (N)	174	287	246	294	163	1187

[a] N = Total number of respondents.
Source: West et al., 1993.

Table 10B-3. Percent of Fish Meals Prepared Using Various Cooking Methods by Ethnicity

Ethnicity	Black	Native American	Hispanic	White	Other
		Total Fish			
Cooking Method					
Pan Fried	40.5	37.5	16.1	35.8	18.5
Deep Fried	27.0	22.0	83.9	22.7	18.4
Boiled	0	1.1	0	4.3	0
Grilled/Broiled	19.4	9.8	0	17.7	57.6
Baked	1.9	16.3	0	11.7	5.4
Combination	9.5	6.2	0	4.5	0
Other (Smoked, etc.)	1.6	4.2	3.5	2.7	4.0
Don't Know	0	0	0.3	0.4	0
Total (N)[a]	52	84	12	1,744	33
		Sport Fish			
Pan Fried	44.9	47.9	52.1	48.8	22.0
Deep Fried	36.2	20.2	47.9	15.7	9.6
Boiled	0	0	0	2.7	0
Grilled/Broiled	0	1.5	0	14.7	61.9
Baked	5.3	18.2	0	8.6	6.4
Combination	13.6	8.6	0	5.6	0
Other (Smoked, etc.)	0	3.6	0	3.7	0
Total (N)	19	60	4	39	0

[a] N = Total number of respondents.
Source: West et al., 1993.

Table 10B-4. Percent of Fish Meals Prepared Using Various Cooking Methods by Education

Education	Through Some H.S.	H.S. Degree	College Degree	Post Graduate Education
		Total Fish		
Cooking Method				
Pan Fried	44.7	41.8	28.8	22.9
Deep Fried	23.6	23.6	23.8	19.4
Boiled	2.2	2.8	5.1	5.8
Grilled/Broiled	8.9	10.9	23.8	34.1
Baked	8.1	12.1	11.6	12.8
Combination	10.0	5.1	3.0	3.8
Other (Smoked, etc.)	2.1	3.4	4.0	1.3
Don't Know	0.5	0.3	0	0
Total (N)[a]	236	775	704	211
		Sport Fish		
Pan Fried	56.1	52.4	41.8	36.3
Deep Fried	13.6	15.8	18.6	12.9
Boiled	2.8	2.4	3.0	0
Grilled/Baked	6.3	9.4	21.7	28.3
Baked	7.4	10.6	6.1	14.9
Combination	10.1	6.3	3.9	6.5
Other (Smoked, etc.)	2.8	3.3	4.6	1.0
Don't Know	0.8	0	0	0
Total (N)	146	524	421	91

[a] N = Total number of respondents.
Source: West et al., 1993.

Table 10B-5. Percent of Fish Meals Prepared Using Various Cooking Methods by Income

Income	0 - $24,999	$25,000 - $39,999	$40,000 - or more
	Total Fish		
Cooking Method			
Pan Fried	44.8	39.1	26.5
Deep Fried	21.7	22.2	23.4
Boiled	2.1	3.5	5.6
Grilled/Broiled	11.3	15.8	25.0
Baked	9.1	12.3	13.3
Combination	8.7	2.9	2.5
Other (Smoked, etc.)	2.4	4.0	3.5
Don't Know	0	0.2	0.3
Total (N)[a]	544	518	714
	Sport Fish		
Pan Fried	51.5	51.4	42.0
Deep Fried	15.8	15.8	17.2
Boiled	1.8	2.1	3.7
Grilled/Broiled	12.0	12.2	19.4
Baked	7.2	10.0	10.0
Combination	9.1	3.8	3.5
Other (Smoked, etc.)	2.7	4.6	3.8
Don't Know	0	0	0.3
Total (N)	387	344	369

[a] N = Total number of respondents.
Source: West et al., 1993.

Table 10B-6. Percent of Fish Meals Where Fat was Trimmed or Skin was Removed, by Demographic Variables

	Total Fish		Sport Fish	
Population	Trimmed Fat (%)	Skin Off (%)	Trimmed Fat (%)	Skin Off (%)
Residence Size				
Large City/Suburb	51.7	31.6	56.7	28.9
Small City	56.9	34.1	59.3	36.2
Town	50.3	33.4	51.7	33.7
Small Town	52.6	45.2	55.8	51.3
Rural Non-Farm	42.4	32.4	46.2	34.6
Farm	37.3	38.1	39.4	42.1
Age (years)				
17-30	50.6	36.5	53.9	39.3
31-40	49.7	29.7	51.6	29.9
41-50	53.0	32.2	58.8	37.0
51-65	48.1	35.6	48.8	37.2
Over 65	41.6	43.1	43.0	42.9
Ethnicity				
Black	25.8	37.1	16.0	40.1
Native American	50.0	41.4	56.3	36.7
Hispanic	59.5	7.1	50.0	23.0
White	49.3	34.0	51.8	35.6
Other	77.1	61.6	75.7	65.5
Education				
Some High School	50.8	43.9	49.7	47.1
High School Degree	47.2	37.1	49.5	37.6
College Degree	51.9	31.9	55.9	33.8
Post-Graduate	47.6	26.6	53.4	38.7
Income				
<$25,000	50.5	43.8	50.6	47.3
$25-39,999	47.8	34.0	54.9	34.6
$40,000 or more	50.2	28.6	51.7	27.7
Overall	49.0	34.7	52.1	36.5

Source: Modified from West et. al., 1993.

Table 10B-7. Method of Cooking of Most Common Species Kept by Sportfishermen

Species	Percent of Anglers Catching Species	Use as Primary Cooking Method (Percent)				
		Deep Fry	Pan Fry	Bake and Charcoal Broil	Raw	Other[b]
White Croaker	34%	19%	64%	12%	0%	5%
Pacific Mackerel	25%	10%	41%	28%	0%	21%
Pacific Bonito	18%	5%	33%	43%	2%	17%
Queenfish	17%	15%	70%	6%	1%	8%
Jacksmelt	13%	17%	57%	19%	0%	7%
Walleye Perch	10%	12%	69%	6%	0%	13%
Shiner Perch	7%	11%	72%	8%	0%	11%
Opaleye	6%	16%	56%	14%	0%	14%
Black Perch	5%	18%	53%	14%	0%	15%
Kelp Bass	5%	12%	55%	21%	0%	12%
California Halibut	4%	13%	60%	24%	0%	3%
Shellfish[a]	3%	0%	0%	0%	0%	100%

(n = 1059)
[a] Crab, mussels, lobster, abalone
[b] Boil, soup, steam, stew
Source: Modified from Puffer et al., 1981.

Table 10B-8. Adult Consumption of Fish Parts

Species	Number Consuming	Weighted Percent Consuming Specific Parts					
		Fillet	Skin	Head	Eggs	Bones	Organs
Salmon	473	95.1%	55.8%	42.7%	42.8%	12.1%	3.7%
Lamprey	249	86.4%	89.3%	18.1%	4.6%	5.2%	3.2%
Trout	365	89.4%	68.5%	13.7%	8.7%	7.1%	2.3%
Smelt	209	78.8%	88.9%	37.4%	46.4%	28.4%	27.9%
Whitefish	125	93.8%	53.8%	15.4%	20.6%	6.0%	0.0%
Sturgeon	121	94.6%	18.2%	6.2%	11.9%	2.6%	0.3%
Walleye	46	100%	20.7%	6.2%	9.8%	2.4%	0.9%
Squawfish	15	89.7%	34.1%	8.1%	11.1%	5.9%	0.0%
Sucker	42	89.3%	50.0%	19.4%	30.4%	9.8%	2.1%
Shad	16	93.5%	15.7%	0.0%	0.0%	3.3%	0.0%

Source: CRITFC, 1994.

APPENDIX 10C

PER CAPITA ESTIMATES BY SPECIES
BASED ON THE USDA CSFII DATA

Table 10C-1. Daily Average Per Capita Estimates of Fish Consumption
U.S. Population - Mean Consumption by Species Within Habitat - As Consumed Fish

Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day	Habitat	Species	Estimated Mean Grams/Person/Day
Estuarine	Shrimp	1.37241	Marine	Swordfish	0.13879	All Species	Flounder	0.24590
	Perch	0.52580	(Cont)	Squid	0.12196	(Cont)	Scallop (Marine)	0.21805
	Flatfish (Estuarine)	0.43485		Sardine	0.10013		Sea Bass	0.20794
	Crab (Estuarine)	0.29086		Pompano	0.09131		Lobster	0.20001
	Flounder	0.24590		Sole	0.07396		Oyster	0.17840
	Oyster	0.17840		Mackerel	0.06379		Clam (Estuarine)	0.14605
	Clam (Estuarine)	0.14605		Whiting	0.05498		Swordfish	0.13879
	Mullet	0.07089		Halibut	0.02463		Squid	0.12196
	Croaker	0.05021		Mussels	0.02217		Sardine	0.10313
	Herring	0.02937		Shark	0.01901		Pompano	0.09131
	Smelts	0.02768		Whitefish	0.00916		Sole	0.07396
	Scallop (Estuarine)	0.00247		Seafood	0.00574		Mullet	0.07089
	Anchovy	0.00228		Snapper	0.00539		Mackarel	0.06379
	Scup	0.00050		Octopus	0.00375		Whiting	0.05498
	Sturgeon	0.00040		Barracuda	0.00111		Croaker	0.05021
				Abalone	0.00075		Carp	0.04846
Freshwater	Catfish	1.06776					Herring	0.02937
	Trout	0.43050	Unknown	Fish	0.00186		Smelts	0.02768
	Carp	0.04846					Halibut	0.02463
	Pike	0.01978	All Species	Tuna	4.19998		Mussels	0.02217
	Salmon (Freshwater)	0.00881		Clam (Marine)	1.66153		Pike	0.01978
				Shrimp	1.38883		Shark	0.01901
Marine	Tuna	4.19998		Cod	1.22827		Whitefish	0.00916
	Clam (Marine)	1.66153		Catfish	1.06776		Salmon (Freshwater)	0.00881
	Cod	1.22627		Faltfish (Marine)	1.06307		Seafood	0.00574
	Flatfish (Marine)	1.06307		Salmon (Marine)	0.73778		Snapper	0.00539
	Salmon (Marine)	0.73778		Perch	0.52580		Octopus	0.00375
	Haddock	0.51533		Haddock	0.51533		Scallop (Estuarine)	0.00247
	Pollock	0.44970		Pollock	0.44970		Anchovy	0.00228
	Crab (Marine)	0.33870		Flatfish (Estuarine)	0.43485		Fish	0.00166
	Ocean Perch	0.31878		Trout	0.43050		Barracuda	0.00111
	Porgy	0.29844		Crab (Marine)	0.33870		Abalone	0.00075
	Scallop (Marine)	0.21805		Ocean Perch	0.31878		Scup	0.00050
	Sea Bass	0.20794		Porgy	0.29844		Sturgeon	0.00040
	Lobster	0.20001		Crab (Estuarine)	0.29088			

Notes: Estimates are projected from a sample of 11,912 individuals to the U.S. population of 242,707,000 using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conteminous states.

Source of individual consumption data: USDA Combined 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals (CSFII).

The fish component of foods containing fish was calculated using data from the recipe file for release 7 of the USDA's Nutrient Data Base for Individual Food Intake Surveys.

Table 10C-2. Daily Average Per Capita Estimates of Fish Consumption
U.S. Population - Mean Consumption by Species Within Habitat - Uncooked Fish

Habitat	Species	Estimated Mean Grams/Person/Day
Estuarine	Shrimp	1.78619
	Perch	0.66494
	Flatfish (Estuarine)	0.50832
	Crab (Estuarine)	0.40848
	Flounder	0.28559
	Oyster	0.18827
	Mullet	0.08959
	Croaker	0.06539
	Smelts	0.03470
	Herring	0.03408
	Clam (Estuarine)	0.03339
	Anchovy	0.00304
	Scallop (Estuarine)	0.00297
	Scup	0.00050
	Sturgeon	0.00040
Freshwater	Catfish	1.38715
	Trout	0.53777
	Carp	0.06012
	Pike	0.02244
	Salmon (Freshwater)	0.01183
Marine	Tuna	5.67438
	Cod	1.47609
	Flatfish (Marine)	1.24268
	Salmon (Marine)	0.99093
	Haddock	0.62219
	Pollock	0.52906
	Crab (Marine)	0.47567
	Porgy	0.42587
	Ocean Perch	0.39327
	Clam (Marine)	0.37982
	Lobster	0.27583
	Sea Bass	0.26661
	Scallop (Marine)	0.26199

Habitat	Species	Estimated Mean Grams/Person/Day
Marine (Cont)	Swordfish	0.17903
	Squid	0.14420
	Sardine	0.13750
	Pompano	0.12160
	Mackerel	0.09866
	Sole	0.08339
	Whiting	0.06514
	Mussels	0.03718
	Halibut	0.03030
	Shark	0.02385
	Whitefish	0.00916
	Snapper	0.00551
	Octopus	0.00457
	Barracuda	0.00130
	Abalone	0.00094
	Seafood	0.00043
Unknown	Fish	0.00248
All Species	Tuna	5.67438
	Shrimp	1.78619
	Cod	1.47609
	Catfish	1.38715
	Flatfish (Marine)	1.24268
	Salmon (Marine)	0.99093
	Perch	0.66494
	Haddock	0.62219
	Trout	0.53777
	Pollock	0.52906
	Flatfish (Estuarine)	0.50832
	Crab (Marine)	0.47567
	Porgy	0.42587
	Crab (Estuarine)	0.40848
	Ocean Perch	0.39327
	Clam (Marine)	0.37982

Habitat	Species	Estimated Mean Grams/Person/Day
All Species (Cont)	Flounder	0.28559
	Lobster	0.27563
	Sea Bass	0.26661
	Scallop (Marine)	0.26199
	Oyster	0.18827
	Swordfish	0.17903
	Squid	0.14420
	Sardine	0.13750
	Pompano	0.12160
	Mackarel	0.09866
	Mullet	0.08958
	Sole	0.08339
	Croaker	0.06539
	Whiting	0.06514
	Carp	0.06012
	Mussels	0.03718
	Smelts	0.03470
	Herring	0.03406
	Clam (Estuarine)	0.03339
	Halibut	0.03030
	Shark	0.02385
	Pike	0.02244
	Salmon (Freshwater)	0.01183
	Whitefish	0.00916
	Snapper	0.00551
	Octopus	0.00457
	Anchovy	0.00304
	Scallop (Estuarine)	0.00297
	Fish	0.00248
	Barracuda	0.00130
	Abalone	0.00094
	Scup	0.00050
	Seafood	0.00043
	Sturgeon	0.00040

Notes: Estimates are projected from a sample of 11,912 individuals to the U.S. population of 242,707,000 using 3-year combined survey weights. The population for this survey consisted of individuals in the 48 conteminous states.

Source of individual consumption data: USDA Combined 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals (CSFII).

Amount of consumed fish recorded by survey respondents was converted to uncooked fish quantities using data from the recipe file for release 7 of USDA's Nutrient Data Base for Individual Food Intake Surveys. The fish component of foods containing fish was calculated using data from the recipe file for release 7 of the USDA's Nutrient Data Base for Individual Food Intake Surveys.

Table 10C-3. Daily Average Per Capita Estimates Of Fish Consumption
As Consumed Fish - Mean Consumption by Species Within Habitat
U.S. Population

Habitat	Species	Estimated Mean Grams/person/day	Habitat	Species	Estimated Mean Grams/person/day	Habitat	Species	Estimated Mean Grams/person/day
Estuarine	Shrimp	1.37241	Marine (Con't.)	Swordfish	0.13879	All Species	Flounder	0.24590
	Perch	0.52580		Squid	0.12196	(Con't.)	Scallop (Marine)	0.21805
	Flatfish	0.43485		Sardine	0.10313		Sea Bass	0.20794
	Crab	0.29086		Pompano	0.09131		Lobster	0.20001
	Flounder	0.24590		Sole	0.07396		Oyster	0.17419
	Oyster	0.17419		Mackerel	0.06379		Swordfish	0.13879
	Mullet	0.07089		Whiting	0.05498		Squid	0.12196
	Croaker	0.05021		Halibut	0.02463		Sardine	0.10313
	Herring	0.02937		Mussels	0.02217		Pompano	0.09131
Freshwater	Smelts	0.02768		Shark	0.01901		Sole	0.07396
	Clam	0.02691		Whitefish	0.00916		Mullet	0.07089
	Scallop	0.00247		Snapper	0.00539		Mackerel	0.06379
	Anchovy	0.00228		Octopus	0.00375		Whiting	0.05498
	Scup	0.00050		Barracuda	0.00111		Croaker	0.05021
Marine	Sturgeon	0.00040		Abalone	0.00075		Carp	0.04846
				Seafood	0.00043		Herring	0.02937
	Catfish	1.06776					Smelts	0.02768
	Trout	0.43050	Unknown	Fish	0.00186		Clam (Estuarine)	0.02691
	Carp	0.04846					Halibut	0.02463
	Pike	0.01978	All Species	Tuna	4.19998		Mussels	0.02217
	Salmon	0.00881		Shrimp	1.37241		Pike	0.01978
				Cod	1.22827		Shark	0.01901
	Tuna	4.19998		Catfish	1.06776		Whitefish	0.00916
	Cod	1.22827		Flatfish (Marine)	1.06307		Salmon	0.00881
	Flatfish	1.06307		Salmon (Marine)	0.73778		(Freshwater)	0.00539
	Salmon	0.73778		Perch	0.52580		Snapper	0.00375
	Haddock	0.51533		Haddock	0.51533		Octopus	0.00247
	Pollock	0.44970		Pollock	0.44970		Scallop (Estuarine)	0.00228
	Crab	0.33870		Flatfish (Estuarine)	0.43485		Anchovy	0.00186
	Ocean Perch	0.31878		Trout	0.43050		Fish	0.00111
	Clam	0.30617		Crab (Marine)	0.33870		Barracuda	0.00075
	Porgy	0.29844		Ocean Perch	0.31878		Abalone	0.00050
	Scallop	0.21805		Clam (Marine)	0.30617		Scup	0.00043
	Sea Bass	0.20794		Porgy	0.29844		Seafood	0.00040
	Lobster	0.20001		Crab (Estuarine)	0.29086		Sturgeon	

Estimates are projected from a sample of 11,912 individuals to the U.S. population of 242,707,000 using 3-year combined survey weights.
Source: U.S. EPA, 1996a.

Table 10C-4. Daily Average Per Capita Estimates Of Fish Consumption
Uncooked Fish** - Mean Consumption by Species Within Habitat
U.S. Population

Habitat	Species	Estimated Mean Grams/person/day	Habitat	Species	Estimated Mean Grams/person/day	Habitat	Species	Estimated Mean Grams/person/day
Estuarine	Shrimp	1.78619	Marine (Con't.)	Swordfish	0.17903	All Species (Con't.)	Flounder	0.28559
	Perch	0.66494		Squid	0.14420		Lobster	0.27563
	Flatfish	0.50832		Sardine	0.13750		Sea Bass	0.26661
	Crab	0.40848		Pompano	0.12160		Scallop (Marine)	0.26199
	Flounder	0.28559		Mackerel	0.09866		Oyster	0.18827
	Oyster	0.18827		Sole	0.08339		Swordfish	0.17903
	Mullet	0.08958		Whiting	0.06514		Squid	0.14420
	Croaker	0.06539		Mussels	0.03718		Sardine	0.13750
	Smelts	0.03470		Halibut	0.03030		Pompano	0.12160
	Herring	0.03408		Shark	0.02385		Mackerel	0.09866
	Clam	0.03339		Whitefish	0.00916		Mullet	0.08958
	Anchovy	0.00304		Snapper	0.00551		Sole	0.08339
	Scallop	0.00297		Octopus	0.00457		Croaker	0.06539
	Scup	0.00050		Barracuda	0.00130		Whiting	0.06514
	Sturgeon	0.00040		Abalone	0.00094		Carp	0.06012
				Seafood	0.00043		Mussels	0.03718
Freshwater	Catfish	1.38715					Smelts	0.03470
	Trout	0.53777	Unknown	Fish	0.00248		Herring	0.03408
	Carp	0.06012					Clam (Estuarine)	0.03339
	Pike	0.02244	All Species	Tuna	5.67438		Halibut	0.03030
	Salmon	0.01183		Shrimp	1.78619		Shark	0.02385
				Cod	1.47609		Pike	0.02244
Marine	Tuna	5.67438		Catfish	1.38715		Salmon (Freshwater)	0.01183
	Cod	1.47609		Flatfish (Marine)	1.24268		Whitefish	0.00916
	Flatfish	1.24268		Salmon (Marine)	0.99093		Snapper	0.00551
	Salmon	0.99093		Perch	0.66494		Octopus	0.00457
	Haddock	0.62219		Haddock	0.62219		Anchovy	0.00304
	Pollock	0.52906		Trout	0.53777		Scallop (Estuarine)	0.00297
	Crab	0.47567		Pollock	0.52906		Fish	0.00248
	Porgy	0.42587		Flatfish (Estuarine)	0.50832		Barracuda	0.00130
	Ocean Perch	0.39327		Crab (Marine)	0.47567		Abalone	0.00094
	Clam	0.37982		Porgy	0.42587		Scup	0.00050
	Lobster	0.27563		Crab (Estuarine)	0.40848		Seafood	0.00043
	Sea Bass	0.26661		Ocean Perch	0.39327		Sturgeon	0.00040
	Scallop	0.26199		Clam (Marine)	0.37982			

Estimates are projected from a sample of 11,912 individuals to the U.S. population of 242,707,000 using 3-year combined survey weights.
Source: U.S. EPA, 1996a.